DATAMATION 61

October

Theodore Friedman, Computer Des En
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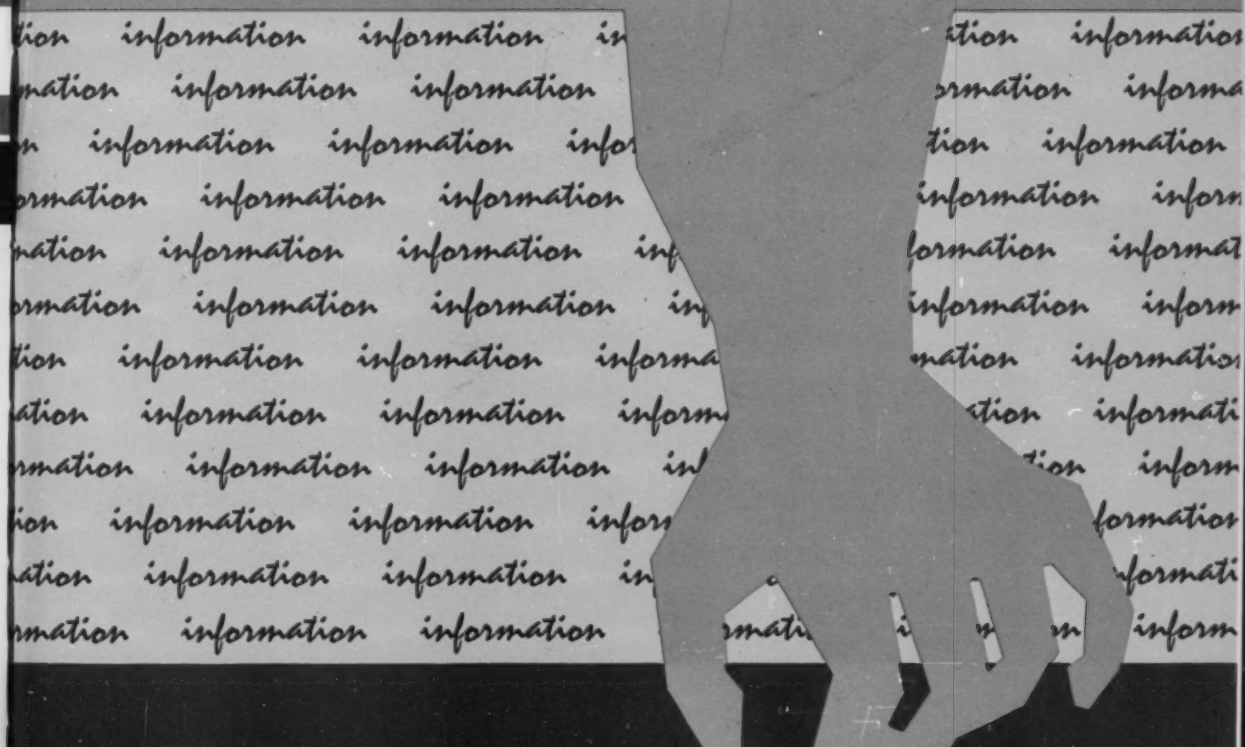

retrieval

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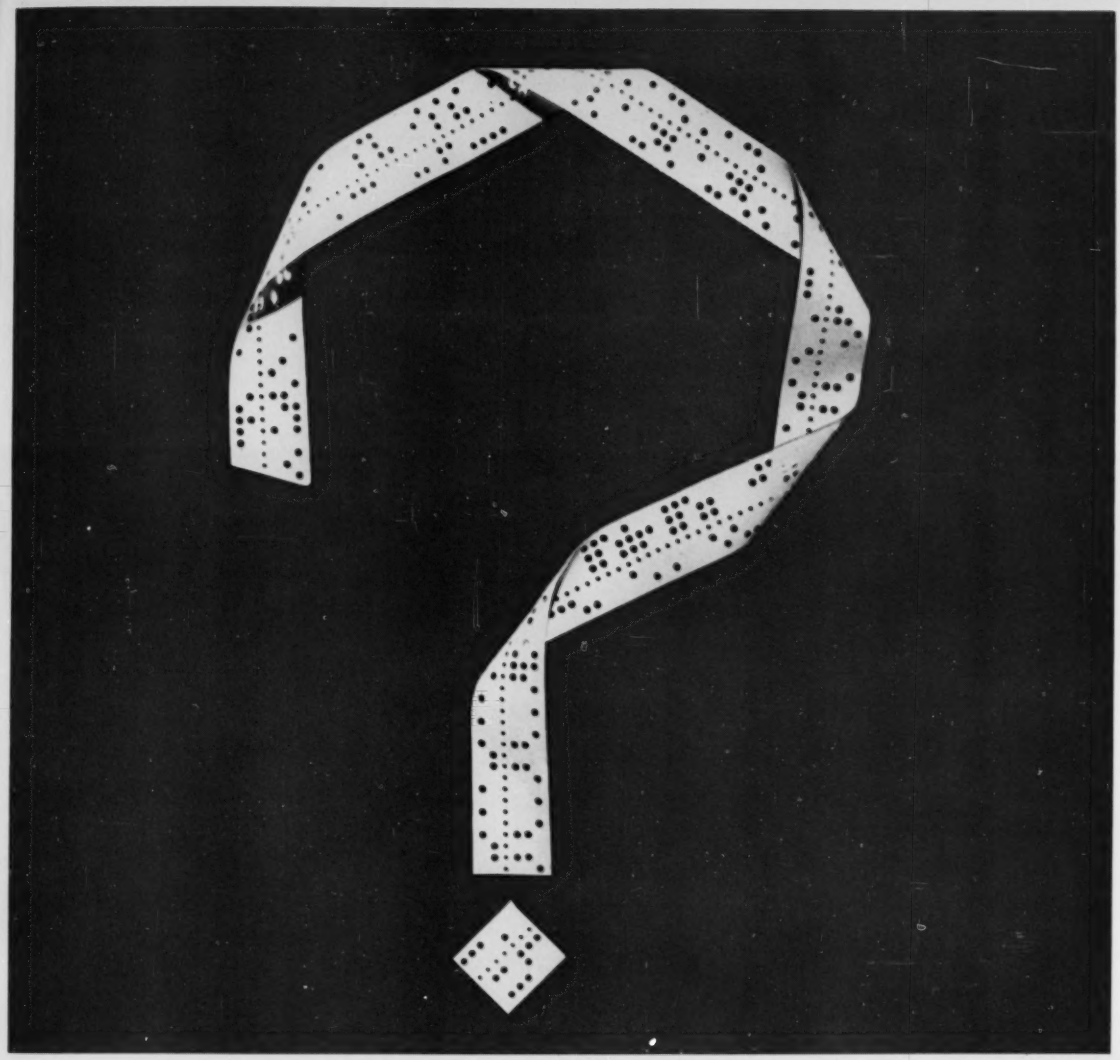

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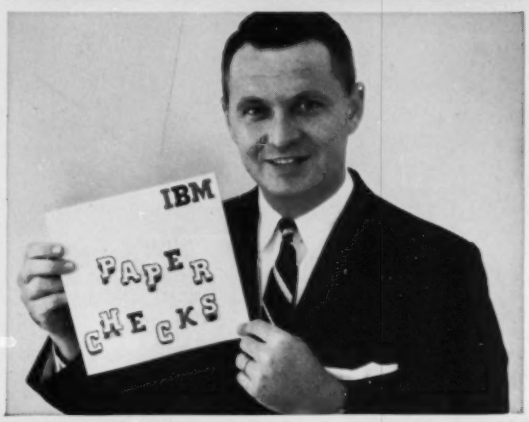

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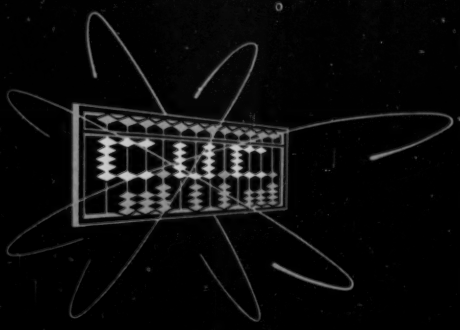

CIRCLE 5 ON READER CARD

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DATAMATION 61

the automatic handling of information

volume 7, number **10**

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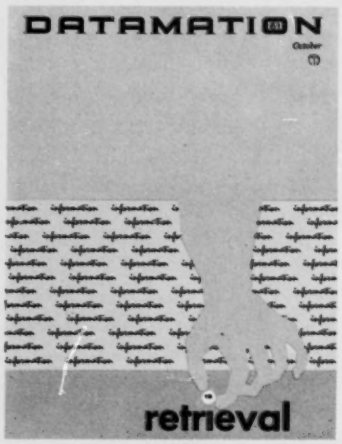

Cover

While "penetrating" is probably one of the more misused journalistic cliches, we find it entirely appropriate for the careful introspection and speculation which DATAMATION's authors have provided for this month's feature treatment on Information Retrieval. The theme of the issue and perhaps a representation of the state of the art as well, are succinctly reflected in the cover design executed by Art Director Cleve Boutell.

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DATAMATION is published monthly on or about the tenth day of every month by F. D. Thompson Publications, Inc., Frank D. Thompson, president. Executive Circulation and Advertising offices, 141 East 44th St., New York 17, N.Y. (MUrray Hill 7-5180). Editorial offices, 10373 West Pico Blvd., Los Angeles 64, Calif. (BRadshaw 2-0817). Published at Chicago, Ill. Accepted as controlled circulation at Columbus, O. Form 3579 to be sent to F. D. Thompson Publications, Inc., 201 N. Wells St., Chicago 6, Ill.

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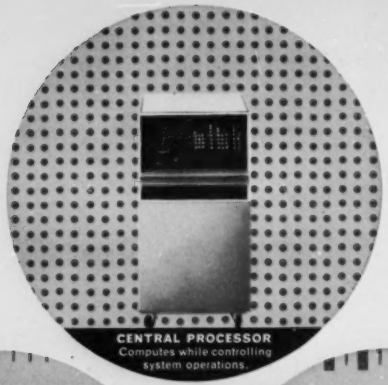
ANNOUNCING THE NEW BURROUGHS B 20



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Computes while controlling system operations.

CARD READER
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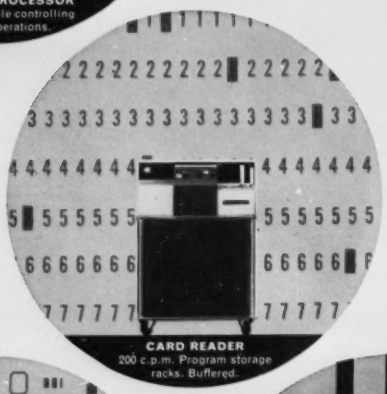

CARD READER
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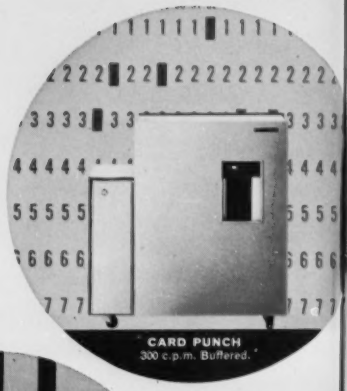

CARD PUNCH
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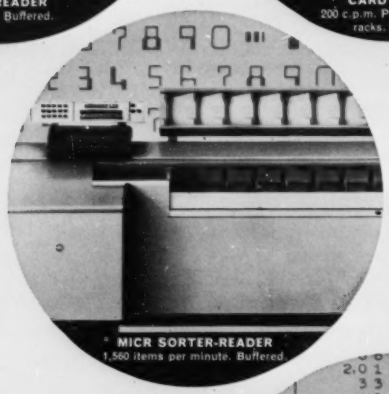

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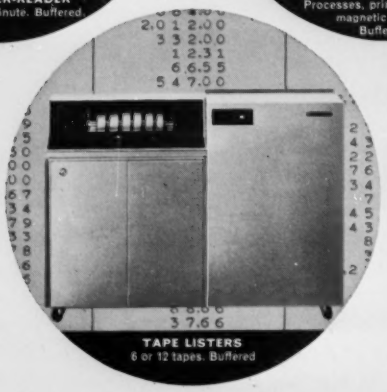

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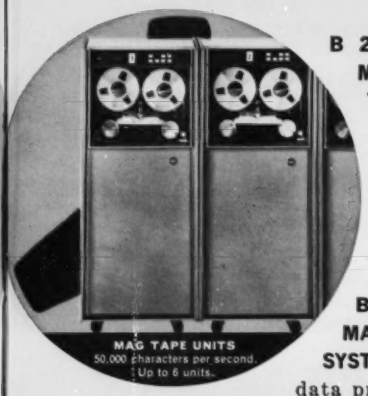

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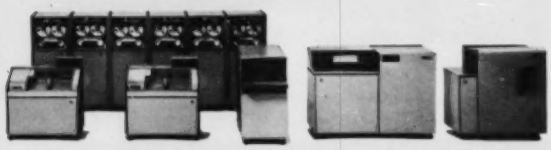

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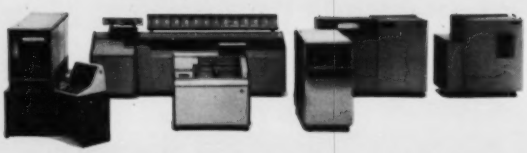

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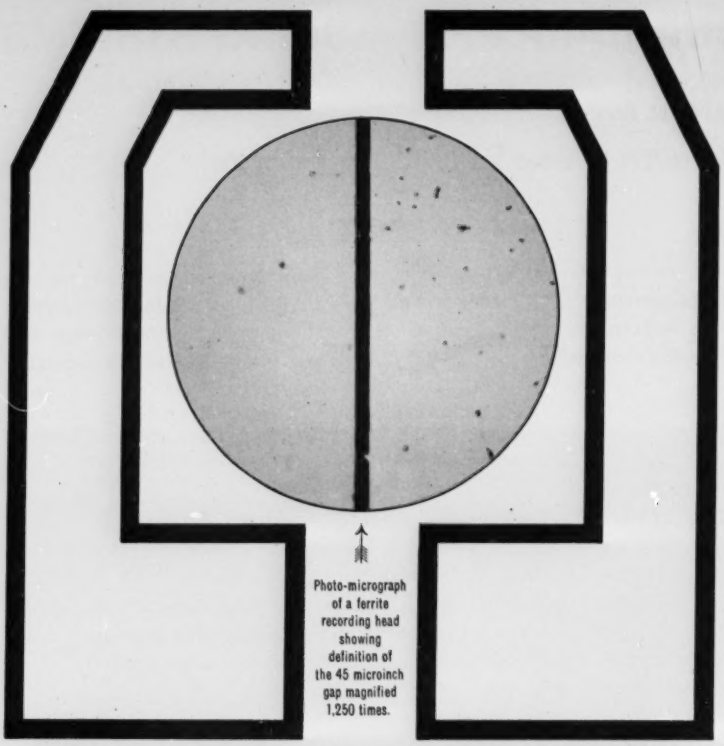

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CIRCLE 7 ON READER CARD

important DATES

• The Assoc. for Data Processing Service Organizations (ADAPSO) will hold its next symposium on Oct. 16 and 17 at the Ambassador Hotel, Los Angeles. Subjects include Operations Research and equipment selection. For information contact ADAPSO, 1000 Highland Ave., Abington, Pa.

• Two forums on legal questions raised by computer use in business, industry and government are being sponsored by the Joint Committee on Continuing Legal Education of the American Law Institute and American Bar Assoc. They will be held on Oct. 19-21, Pick Congress Hotel, Chicago, and Dec. 14-16, Statler-Hilton Hotel, Los Angeles.

• The 1961 Computer Applications Symposium, sponsored by Armour Research Foundation will be held Oct. 25-26, Morrison Hotel, Chicago. For information write to Benjamin Mittman, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

• The National Machine Accountants' Assoc. Electronic Business Systems Conference is set for Oct. 25-27 in Long Beach, Calif. For information write to NMAA Western Division, P.O. Box 7365, Long Beach, Calif.

• The Institute on Electronics in Management, sponsored by The American University will be held Oct. 30—Nov. 3rd at The American Univ., Wash., D.C. For information contact Prof. L. H. Hattery, The American Univ., 1901 F Street, N.W., Wash. 6, D.C.

• The 1961 Eastern Joint Computer Conference is scheduled for Dec. 12-14 at the Sheraton-Park Hotel, Washington, D.C. Theme of the Conference is "Computers—Key to Total Systems Control."

• The Office of Naval Research, Information Systems Branch, is sponsoring a symposium on Redundancy Techniques for Computing Systems which will be held on February 6-7, 1962, in the Department of the Interior Auditorium in Washington, D.C.

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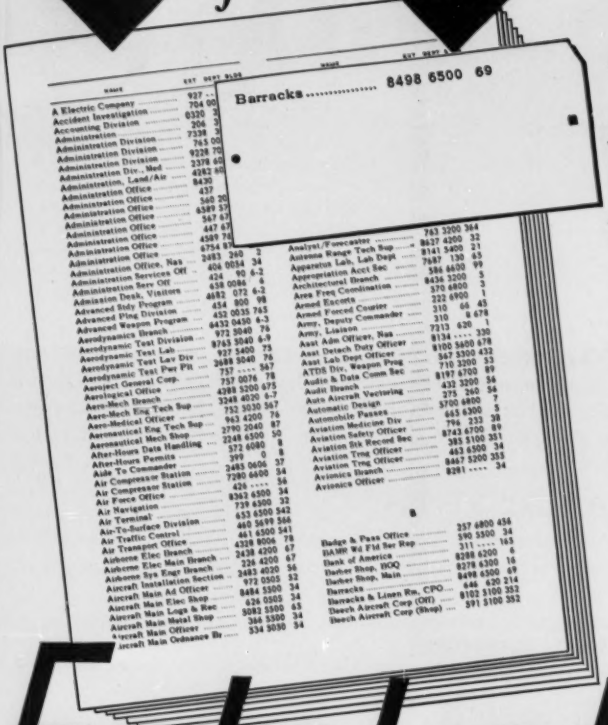

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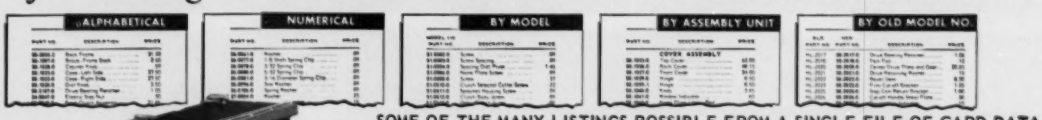

SOME OF THE MANY LISTINGS POSSIBLE FROM A SINGLE FILE OF CARD DATA

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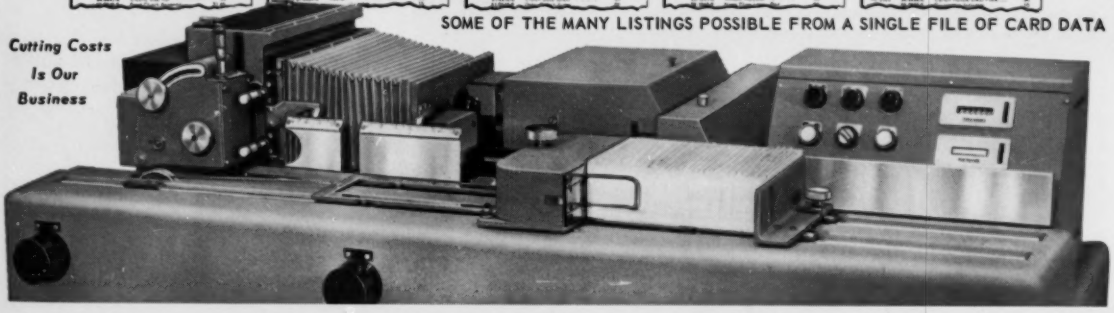

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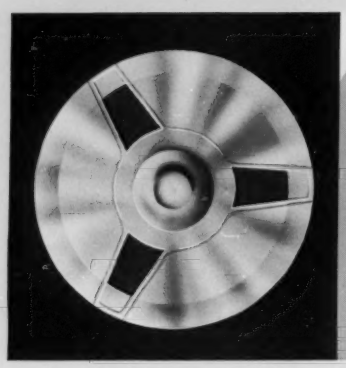

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letters

computers & man: an exception to a qualitative distinction

I would like to take partial exception to some comments in a recent letter by P. B. Wright (August, 1961 issue). Mr. Wright objects to the class of terminology which, taken loosely, may delude one into discarding the qualitative distinction between machine and man. If I read him correctly, he would claim that this qualitative distinction is a logical necessity. Thus, for example, when he objects to the statement that a computer can "add," it seems evident that what he means is not that the machine is incapable of performing "1 + 1 = 2," but that it is merely following a built-in pattern, and has no understanding of the "underlying physical meaning" of the symbols involved.

But is it not true that this is also a fair representation of the approach of the great majority of humans to the same problem? If by "underlying physical meaning" we imply the representation of integers by denumerable sets, it is not difficult to design a device capable of making the same correlation. On the subject of "learning," much of the learning process in man consists of the development of a pattern of responses on the basis of previous experience. Computer programs which do just this have been written and successfully demonstrated.

I am not arguing against the concept of a basic distinction, but I believe that a qualitative distinction between machine and man is not a logical necessity. Rather I accept it as an axiom of my Weltanschauung. What I would say then, as to the applicability of these "anthropomorphic" terms (as Mr. Wright calls them) to machines is that we have been successful in building devices which can perform certain operations of a routine nature which can also be performed by man. What difference does it make whether I add a column of figures and type the answer or a machine performs the same function? The answer is just as legible, just as available for interpretation either way. The same amount of "creative thought" has entered into it in each case (i.e., none). The process is still addition.

Let us then say that we have taken a certain class of operations which can be (and usually are) performed by humans on a subhuman level, and have built automata to do this work. The application of the process name (e.g., "addition") merely serves to point out more clearly the subhuman nature of the process. In short, anything which a machine can be "taught" to do (forgive me, Mr. Wright, but I think the context makes the term unambiguous) is, ipso facto, subhuman. If this is called a "human conceit," I would say that it is a built-in one, and not the result of any reasoning or learning process.

HENRY J. BOWLDEN
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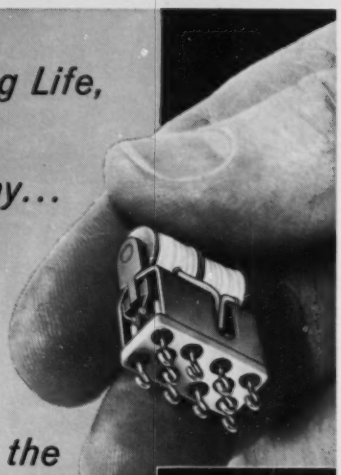

TYPE LF relay shown (cover removed) is 2-coil design which controls entire latching operation within relay. (Actual size).

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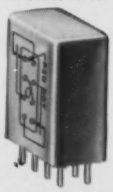

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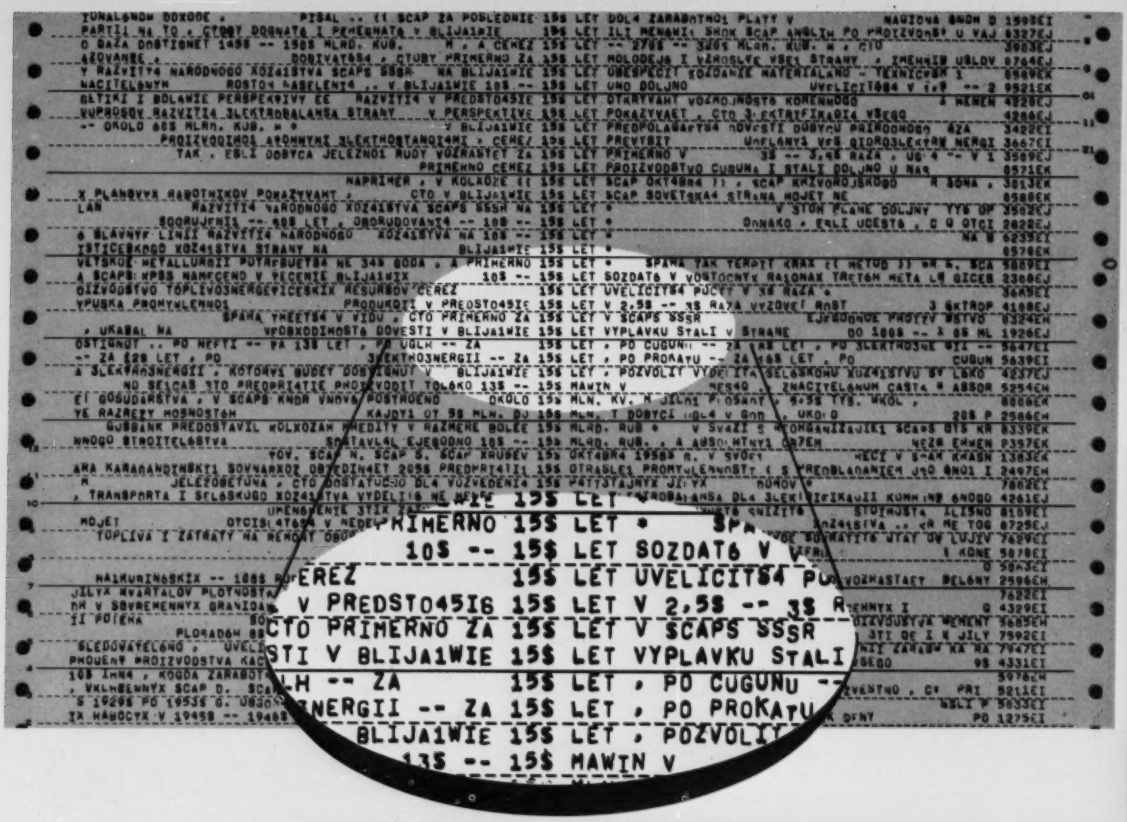
PRIMERNO 15$ LET •
10$ -- 15$ LET SOZDAT6 V
EREZ 15$ LET UVELICIT$4
V PREDST045I6 15$ LET V 2,5$ -- 3$
CTO PRIMERNO ZA 15$ LET V SCAPS SSSR
STI V BLIJA1WIE 15$ LET VYPLAVKU STALI
LH -- ZA 15$ LET , PO CUGUNU --
NERGII -- ZA 15$ LET , PO PROKATU
BLIJA1WIE 15$ LET , POZVOLIT
13$ -- 15$ MAWIN V

WHAT ARE THE SOVIET SCIENTISTS SAYING THIS WEEK IN AVTOMATIKA i TELEMEKHANIKA?

The above illustration is an excerpt from the Scientific Russian Dictionary currently in preparation at PHILCO. When completed, an invaluable tool in translating Russian technical publications will be at our disposal. This activity is a cooperative effort between the PHILCO staff and linguists at Georgetown University. The PHILCO 2000 Computer was selected for this project because of its exceptional speed, reliability and economy of operation. ■ The building of a concordance for subsequent language translation is achieved by the analysis of key words contained in selected Russian technical manuals and books. Pictured on either side of this key word is the context as it appears in the original text. ■ Numerous challenging programs, similar to the above, currently exist at PHILCO and offer important opportunities to enhance professional reputation with an excellent scientific environment. If you are seeking an opportunity for professional growth and accomplishment in a rapidly expanding organization, you are invited to forward your resume in complete confidence.

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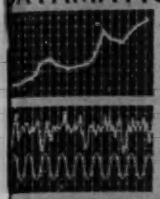


BUSINESS & SCIENCE

BURROUGHS D 825: LARGE SCALE POTENTIAL

aving recently secured a study contract for the rgest government project ever awarded to a computer nufacturer, Burroughs Corp. will furnish the D 825 mputer as part of a $63 million NORAD system. The rst D 825 however, will be installed for the Navy der another special contract and could possibly come Burroughs' first, very-large scale entry in e commercial market.

In size, speed and overall capability, the D 825 y fall somewhere between the 7090 and LARC. For mmercial applications it could be delivered at out the price of a 90.

In physical organization, the computer is quite milar to the B 5000. It also features Polish Notaon although the logical design differs considerably om the 5000. An impressive aspect of the system is a all, very fast, thin film memory similar to the 1107 th over 50 registers. Core memory is 65K with prosion for expansion to 128K with an average access me of 1 microsecond. Word size is 48 bits and the stem is rated at three megacycles.

The D 825 is being manufactured at Burroughs' Paoli cility and if a decision is reached on commercial ailability, it will probably be at least a year fore an announcement is made.

The computer per se is only a small part of the RAD (425L) contract which includes extensive comnications and display systems. However, the virtue the D 825 as well as the company is evident from e recent competition for the contract with such rmidable contenders as IBM and Aeronutronic (in a int bid); Philco (previously reported in another blication as having received the contract); RCA, ntrol Data, General Electric, etc. It may well be id that every large systems manufacturer and several etenders to the throne tossed their prototypes and st salesmen into the contest.

TRW TO MARKET AN/UYK COMMERCIALLY

spite the lack of commercial sales for the RW 400 lymorphic concept, Thompson Ramo Wooldridge has firm ans for expanding its position in the non-military mputing market. Before the end of this year, anuncements may include the commercial availability the small-scale AN/UYK-1 stored logic computer, al-

though it will be marketed as the TRW 530.

Renting for approximately $2,000 per month, the AN/UYK has experienced considerable success in the military market. For commercial applications however, the word size will be increased from 15 to 18 bits and a selection of I/O equipment will be available. Ten AN/UYK's are presently being installed internally by TRW.

For large scale applications (although a considerable distance further away from the commercial scene than AN/UYK) is the CM 403, a general purpose, polymorphic successor to the 400. Presently under development at TRW, the 403 is considerably larger than the 7090 and directed at "handling both business and engineering problems." It is being designed for use either independently or as part of a polymorphic concept.

Under air force contract, the polymorphic concept is presently being integrated with a 1604 and has received renewed financial support from the Rome Air Development Center to effect a master switching program.

Also under development by TRW is a commercial form of the polymorphic concept combined with a version of AN/UYK.

It is certinly gratifying to note the increased attention which TRW is directing at the commercial fiel and it is hoped that far greater emphasis will be placed on the marketing of future computers than the RW 300 and 400 have received.

PHILCO's 2400: HARDWARE UNSUNG & UNSOLD

Announced earlier this year, the 2400 has been billed only as a satellite for the large-scale 2000 system. Never publicly discussed is the fact that the system is presently available as a small scale computer leasing for about $7,800 per month. A console for the 240 does exist but has never been illustrated and the computer can be purchased from Philco but has not been advertised, announced or as yet, sold as a separate machine.

The paradox may be simply explained by the fact tha a decision has not been reached by Philco's managemen to enter the 1401-1410 market which would mean an expanded sales force and field maintenance staff coupled to a heavy additional investment in the computing business.

The recent purchase of Philco Corp.'s assets by the Ford Motor Co. has been attributed in part, to Ford's interest in the computer division which it is assumed will continue as a wholly-owned subsidiary of Ford, the present parent of Aeronutronic. It is also likely that changes in management direction such as entry into the small scale market may occur. Next year Philco's 2000 posture in dp should be more clearly apparent when 7090 users begin shopping for a faster, larger system.

IBM's ALGOL IS NOT AVAILABLE

Posted on the bulletin board at the recent ACM conference in Los Angeles was a listing of all compilers presently completed, their completion dates, and the machines for which they were prepared. The tabulation was presented and posted by IBM's Bob Bemer and included the attention-getting fact that an ALGOL processor for the 7090 was completed by IBM as of December, 1960.

Athough this was assumed by many registrants as an announcement of availability (although indeed, a curious one), this is not the case. The processor which was prepared and listed as completed was written on an internal, experimental basis for educational research only. It is likely that if an ALGOL processor was developed for IBM users, it would not be this one.

However, field testing of this ALGOL processor will take place by a number of SHARE ALGOL committee members early next year. And while testing is hardly to be considered an IBM endorsement of ALGOL or the outdating of FORTRAN, progress in this direction is interesting to note in view of the following excerpt:

In the March, 1961 issue of The Computer Bulletin, publication of the British Computer Society, an article on "Survey of Modern Programming Techniques," by R. W. Bemer was published and we quote in context from p. 130: ". . . I have enough faith in the eventual future of ALGOL to have caused a program to be constructed which converts from FORTRAN source language into a rather stupid ALGOL. I have been asked many times why we did not make it translate from ALGOL to FORTRAN so that the existing processors could be utilized. The answer has always been that we wish to obsolete FORTRAN and scrap it, not perpetuate it. It's purpose has been served . . ."

1401 SALES ARE BOOMING

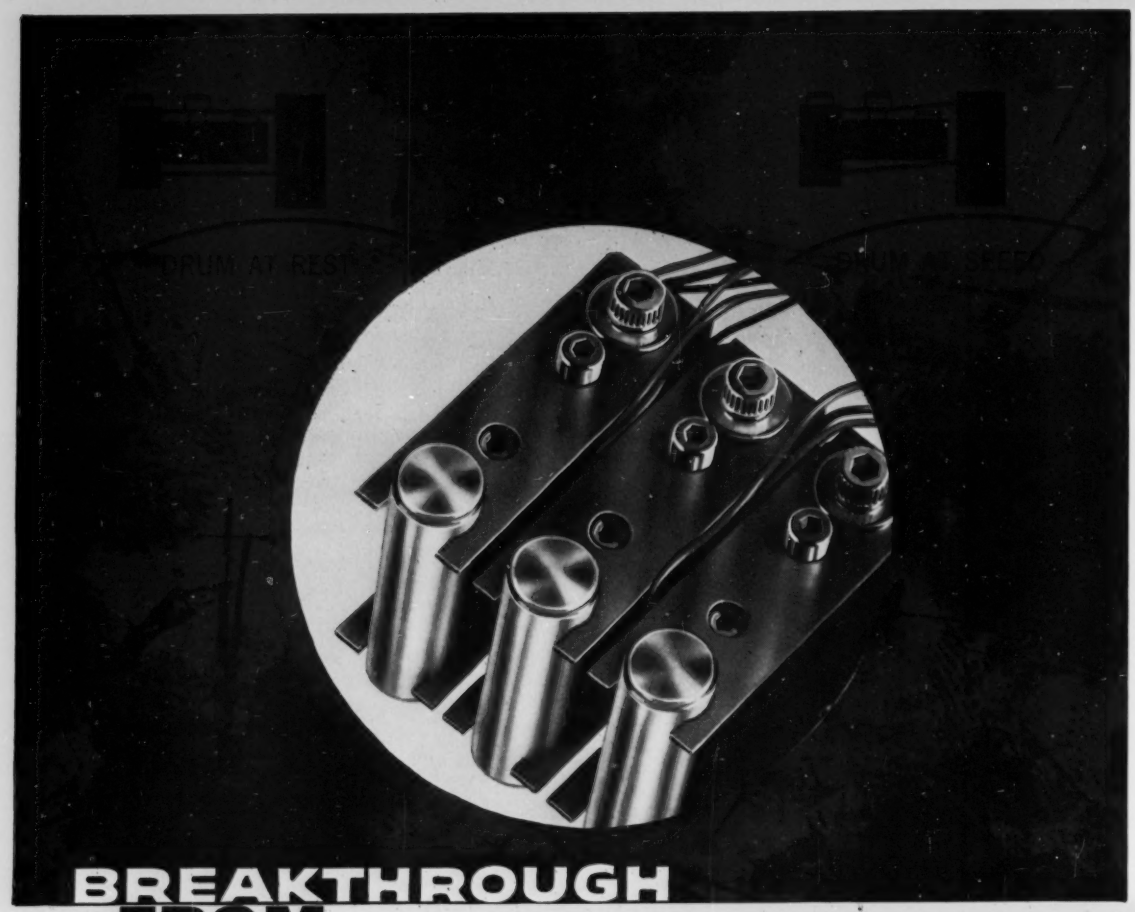
At present, at least 11 1401's are being installed per calendar day with a total of more than 5,000 on order. It is also estimated that over 75 per cent of these installations have taken place in IBM's western region with aircraft firms as principal customers.

A PROFILE OF COMPUTING GROWTH

The size of the computing industry and its growth potential may be briefly summarized as follows: Rental for main frames and peripheral gear now exceeds $600 million annually in this country. World-wide rentals are currently in excess of $750 million. Within two years it is predicted that the U.S. figure will top the $1 billion mark and the world-wide estimate should be over $1.3 billion. By 1965, the computing industry should climb over $2 billion annually and over $2.7 billion internationally.

At present, there are well over 60,000 full time programmers and operators of general purpose, internally programmed computers. Including part-time employees, this figure exceeds 100,000. It is expected that within five years there will be a need for 175,000 programmers and operators on a full-time basis.

Manufacturers of computing equipment currently employ more than 80,000 persons in all phases of engineering, design, production and marketing.



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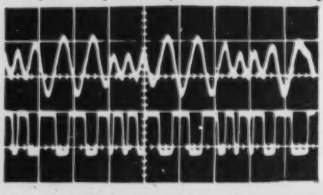

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CIRCLE 11 ON READER CARD

EDITOR'S READOUT

OF DREAMS AND DRIBBLE

In an industry still in its infancy but feeling the potential of manhood, dreams have valuable functions. They serve as a motivating drive toward eventual reality, a creative respite from practical labor, a sometimes impressive vehicle for progress, and certainly, as candied delights to manufacturers rationalizing the daily pains of financial loss.

Of more immediate importance, dreams which are verbalized and actively propagated gather wide publicity, and a good press is a treasured commodity at any time resulting in heavy attendance at computer conferences, inflated stock prices, larger research expenditures, and occasionally, the sale of a computer.

On the working level, dreamers of an outspoken bent may find themselves of far greater value to an organization because of the corporation's acceptance of their dream rather than for any specific accomplishments or their ability at functioning productively on a job.

And while the importance of dreaming is not to be underrated, when the mixture of reality to dreams becomes distorted so that today's work is subordinated to consideration of tomorrow's world, dreaming may in fact, become an all-consuming, quite insidious dribble.

To some extent, this has already occurred. A few examples may serve to illustrate the point:

1. Computers the size of golf balls and match boxes have been propagated at a recent computer conference and the only question raised was that of interconnection with I/O devices. The feasibility of the golf ball concept was blithely accepted while possible applications were not even mentioned. More recently it was explained that business executives could carry these spectacular devices on vacation trips. The most sensible inquiry heard was, "Why?"

Rather than golf ball computers, a need is clearly apparent for such simple necessities as an accurate real time clock within a reasonable price range or tape drives which function with a reliability approximating that of the main frame.

2. Compilers which generate compilers with monotonous regularity have been bandied about with carefree abandon. However, there has been no suitable explanation as to how a simple (malfunctioning) compiler can be written by bright programmers who have not attained acceptable priest-like status, an apparent requisite for compiler writing.

3. Computers designed to eliminate programmers have been widely hailed and perhaps bring sharper focus to the fact that as yet, we lack minimum educational facilities to produce enough talented programmers so that they may proceed in proper fashion, to eliminate themselves.

4. Grand information retrieval projects such as storing the Library of Congress in a memory the size of a homogenized milk container may be practical next week except that automatic indexing is still a matter for grey-haired ladies wearing green eyeshades, bifocal lenses and working at old, wooden desks flooded with eagerly prepared technical reports possibly on this very subject.

5. Simulating a corporate structure in a working model of the economy of the country (or universe, if foreign trade is involved) may be more

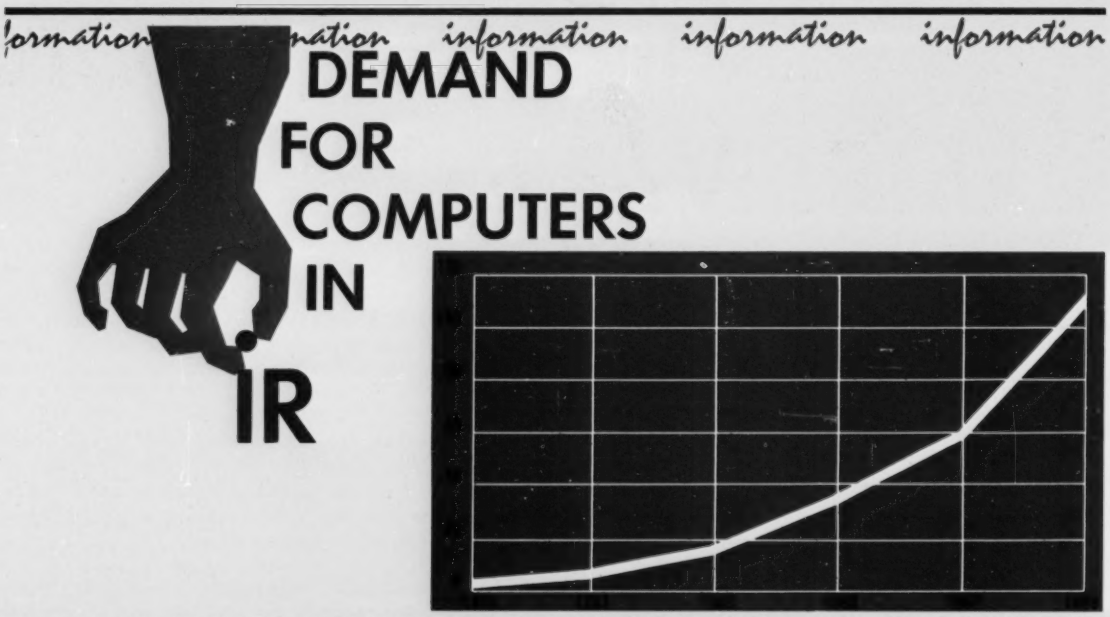
practical for the future if increased attention were paid to running present-day payrolls and inventories with greater efficiency and far less patching.

6. New words are coined almost daily to provide a prophetic character to concepts which may hardly be new at all. Frequently, the devotion to a word is such that it may overshadow the more basic truth that the individual or company urging its acceptance has contributed little of consequence to the growth of the industry.

The creation of words becomes equally ludicrous when evaluated in the light of a widespread lack of agreement as to the meaning of "computer" or "data processing" or "bit" or for that matter, any single word relevant to the industry. For this reason perhaps it may be easier to accept "simulintellecteticynosonics," or some such breed!

There are of course, prophets of noble intentions and to persons of this ilk, DATAMATION extends warm support and encouragement. The propagandists of dribble however, may easily overshadow worthwhile dreams for their intentions are based on self-indulgence and require substantial financial remuneration for sustenance.

The problem is that while the public may blissfully absorb half-truths and visions of dishwashing by computer (with no basic injury to the profession), the mere reiteration of an argument (as foolish as it may sound) is sufficient to sway the thinking of erudite computer people with visions of greater glories difficult to achieve when one requires an eight hour day to write a single instruction.



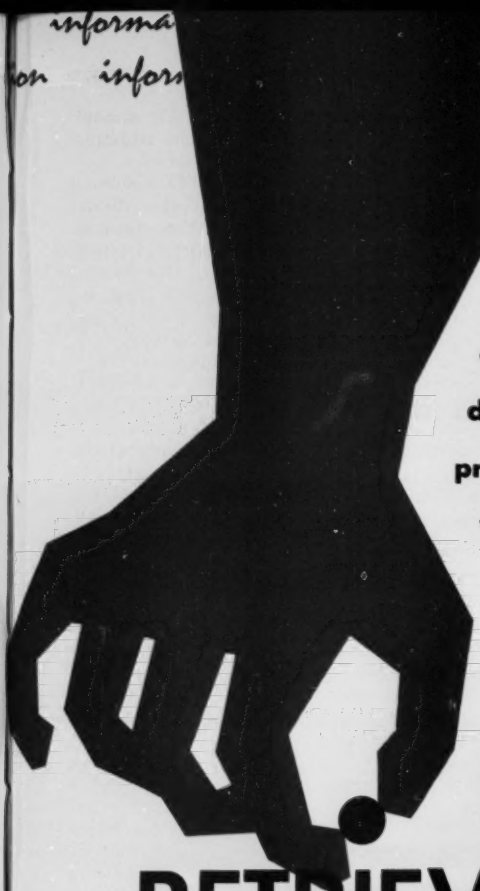
The growth of mechanized Information Retrieval is predicted as a substantial one by Peter H. Butterfield of S.R.I. His estimate is that U.S. industry and nonmilitary government agencies will spend about $6.5 million on computing power for I.R. (where an organization uses its equipment for more than one purpose, as is typically the case, the cost charged to I.R. is estimated proportionately). The annual total, Butterfield forecasts, will climb to $35 million a year by 1965 and to $110 million by 1969. These estimates do not include the vast sums that will also be spent on punched card equipment and other storing and searching hardware for I.R.

Estimated Annual Computer Expenditures for Information Retrieval in the U.S. *(a,b)* Millions of Dollars

a) **Computer rental charges paid by industry and nonmilitary government agencies. Governmental use now accounts for about half of the total expenditure.**

b) **Estimates include general purpose computers programmed for file searching, as well as special purpose machines that use stored or built-in programs for searching information indexes. These estimates take into account the fraction of the time these computers are actually used for I.R.**

Source: Peter Butterfield, Stanford Research Institute, and Chemical & Engineering News, No. 29, Vol. 39



a discerning probe with sharpened scalpel

INFORMATION RETRIEVAL — 1961

by EUGENE MILLER, President, Documentation, Inc., Washington, D.C.

Information retrieval takes on some of the aspects of a fluffy cloud on a bright summer's day. It appears to be standing still and is the epitome of serenity. But if you have ever seen time-lapse photography of an innocent cloud, it is, in fact, a boiling mass of energy in a high state of entrophy. To define the state of the art of I.R. is almost an act of argument. The field is dominated as much by political considerations as technological ones. Most views are biased and subjective and it is difficult for the reader to tell which is not.

From this, however, one conclusion can be clearly drawn: the field is important. There is little point in expanding here the often-stated facts that the power of adequate decision lies in being properly informed; that full information utilization prevents waste of technological manpower and effort. One of our largest business machine companies is alleged to feel that I.R. has a potential larger than the field of accounting.

In a recent issue of the *New York Times*, a special supplement prepared by the IBM Company bore the title, "The Information Explosion." This apt phrase describes the reason for the emergence of I.R. as an important technological field. Information digestion technology must keep pace with that of data ingestion.

Perhaps the most encouraging thing about the current period in the I.R. universe is that it is undergoing a phase of self-examination and self-definition. I.R. people were not sure whether they were dealing with the library sciences, the communications sciences, or computer technology. Actually, of course, I.R. is an applications technology and properly draws upon many scientific disciplines. Those who will achieve ultimate success in the field have already acquired the proper technical balance in their organizational make-up.

We see now that I.R. techniques are much less related to library techniques than they seemed to be several years ago. We can also see that I.R. is much less related to computer technology than the computer people thought it was. I.R. technology *assumes* the unpredictable question and therefore provides a highly manipulative apparatus that is capable of arranging the store at will to suit a wide range of inquiry requirements.

Without detracting at all from the manifest success of time-tested library techniques in coping with the broad spectrum of library problems, it is evident that I.R. encompasses a much broader field. It is concerned with the retrieval of stored items upon demand, no matter what those items may be. Basically it treats items of hardware

stored in a warehouse, or engineering drawings stored in a file drawer, or bits of data stored in an electronic "memory," in a manner similar to books or reports literature stored on a library shelf. It effects retrieval through identification of stored items by matching terms of the inquiry to terms of an item description made expressly for retrieval purposes. Upon the precision of this match and the quickness with which it is performed depends the effectiveness and acceptability of the I.R. operation. In many areas, the requirement for precision and timeliness of response far exceeds that of the library field. Hence, I.R. tends toward far deeper description of the item and high manipulative speeds, neither of which is handleable or realizable without machine aids.

Somewhere in the brash young days of the high-speed electronic computer, computer enthusiasts felt that their devices could do anything, including library work and particularly I.R. They were only partially right in their assertions. After several years of wrangling and unproductive experimentation, theoretical considerations began to produce helpful definitions and the picture now becomes clearer.

It was important that a distinction be made among the kinds of data being processed and the different processing objectives. In mathematical work, computers deal with highly formalized propositions, rigid rules of procedure, and data whose meaning is clearly agreed upon in advance. It generally involves a large number of complex arithmetic operations on a limited variety of data. Business accounting data processing is similar except that the operations are not so complex while the volume of data is much larger.

Careful examination of the I.R. problem parameters reveals substantial differences from data processing for computation, accounting, or statistical operations. While it is obvious that computer equipment can be and is useful for I.R. work, we have found that our computer programmers, experienced in other fields, have had to undergo a drastic revision in their thinking to successfully apply the computer mechanisms to I.R. problems. Virtually no data transformations are involved. Arithmetic elements are used to perform non-arithmetic functions. Logic capabilities of most computers, which seemed to be so ample for other problems, turn out to be extremely skimpy for I.R. work. Filing, ordering, and look-up functions are enormously magnified. Precise outputs are expected of rather non-precise inputs. It is extremely easy to run costs completely out of sight without achieving desired improvements.

We now know that the data processing for I.R. is quite different from data processing for other purposes and that today's general-purpose computers may be useful in the field, although not ideal. Knowledge of computer shortcomings has been acquired through actual use of them, and we are becoming nearer the practical realization of the kind of equipment that must be designed effectively to serve the I.R. field. This may not sound like much of a gain, but it is. It means that in the near future there will be I.R. machine devices offered at a reasonable price that will meet the general requirements of a complete information storage and retrieval system. They will be designed specifically for I.R. purposes.

research in the I.R. field

I.R. has acquired a mathematical foundation only in the past decade. Until then it was a practical art with a long and sometimes brilliant history. During this history, however, great advances occurred no more frequently than great philosophers, say, once every hundred years. It may be that providing a mathematical foundation will be the only advance for the next hundred years, but certainly the current impetus in terms of money and effort is unprecedented.

For the most part, research in the field of I.R. is government-sponsored, largely by science-oriented agencies. There are a small number of government offices that support research projects proposed by both profit and non-profit organizations. However, for some strange reason, "profit" is almost a dirty word in some government circles and unsolicited research proposals from profit-oriented organizations are given scant consideration. One of the most important science agencies virtually asserts that the research capability of profit-making organizations cannot serve the government's interest in the advancement of science. If, by some aberrative quirk of capitalistic thinking, a profit-motivated group should persist in its desire to contribute to science, it must do so partially, at least, at its own expense.

The result of this government policy is that there is a considerable imbalance in the current I.R. research program. Because there is virtually no profit in government research contracts, profit-oriented organizations tend toward highly pragmatic research projects that will yield fairly quick results and that will help solve clearly established, immediate problems. Non-profit organizations (particularly universities) have different goals and tend toward more basic investigations that may or may not have a payoff in the indeterminate future. There are many immediate and urgent problems in the I.R. field that are crying for solution. The state of the art would surely be advanced if such efforts were more vigorously supported.

To be specific, a disproportionately large bulk of money being expended in I.R. research today is in the area of linguistics and semantic content of messages or terms of messages. This emphasis is justified on the ground (other than the profit versus non-profit canard) that the intent of communications is to convey meaning and therefore we should investigate the nature of meaning before worrying too much about the mechanics of communicating it. It's like saying we should never fire boilers before understanding the fundamental nature of combustion. To be sure linguistics and semantics are important and legitimate research areas and should be supported. But today we need answers to other questions, such as:

- Response failures of I.R. systems are frequently the result of inadequacy in phrasing the question in terms of the system vocabulary. How can this problem be overcome?
- Uncontrolled growth of information collections permits an increasing amount of repetitious and duplicate data and just plain junk. How can we keep junk from getting in and how can we get obsolescent material out?
- Input costs are the highest costs in an I.R. system. How can they be reduced?
- There is no academic discipline for the I.R. field. It is badly needed. How can it be established?

These are but a few of the urgent questions of the day. A good answer to any one of them will result in a significant advance.

As indicated earlier in this article, the struggle for agreement on definitions is one of the outstanding facets of today's I.R. world. It is really a striving for understanding so that balance can be achieved in the I.R. research programs. The depth and fundamental character of this examination are well illustrated by a recent paper by my colleague, Mortimer Taube[1], published by *The Library Quarterly*.[2] The following excerpt is taken from Taube's discussion of the nature of "information" as we in the I.R. field must examine it.

"In the past several years there has been considerable discussion in both technical journals and the public

press of the creation of a new basic theory, namely, information theory. *Fortune* magazine has gone so far as to say that the creation of information theory is an intellectual advance as important as the theory of gravitation and that it will have the kind of consequences in the field of information that Newton's theory of gravitation had in mechanics and physics.[3] Alongside this most laudatory view, there have been many who have been quite resentful of what they have called the pre-emption of a word like 'information' to cover certain mathematical relationships which have nothing to do with 'information' as ordinarily understood . . .

"Information can be interpreted 'extensively' as a statistical property of 'messages' without any reference to meaning and semantics . . .

". . . We are told that anyone who searches directly for happiness will make himself acutely miserable; that happiness is achieved only indirectly, when it is not the specified goal of activity. Similarly, we have witnessed in the last few years the obscuration and even nonsense that has come out of those activities dedicated to a search for the meaning of meaning or for the semantic key which will unlock the very storehouse of knowledge. There is no such key, any more than there is a one and true meaning to any word or a one and true color experience which is purely this hue and no other. Meaning is the eternal vestal virgin. She is to be saluted and not embraced. If we seek to possess her once and for all, we destroy her and remain with empty arms. What I am saying is that, if we concentrate on information as a physical property of meaning and on the best ways of organizing this kind of information, we can approximate, as closely as we please, the meanings which are important to us. But, if we begin by trying to catch meaning in our gross physical nets, we will end in disaster and confusion or as a mystic cult."

Such is the nature of discussion and argument in the I.R. field today. It is an arena of controversy. It would not be very important if it were otherwise. ■

NOTES

[1]Chairman of the Board, Documentation Incorporated, Washington, D.C.
[2]Mortimer Taube, "Documentation, Information Retrieval, and Other New Techniques," *The Library Quarterly, Vol. XXXI*, No. 1, Chicago, University of Chicago, 1961, pp. 90-103.
[3]Francis Bello, "Information Theory," *Fortune, XXVIII*, December, 1953, 136 ff.

In 1945 Eugene Miller, President of Documentation Inc., organized and became Chief of the Division of Research Information of the National Advisory Committee for Aeronautics, a position held for seven years. Prior to joining NACA, Miller served as Deputy Director for Operations of the Armed Services Technical Information Agency in 1952 and 1953, and is also past president of the American Documentation Institute.

information information information information information

accomplishments and bumbles appraised and projected

INFORMATION RETRIEVAL — 1966

by BENJAMIN F. CHEYDLEUR, Technical Planning Staff, Computer Division, Philco Corp., Willow Grove, Pa.

In the last few years, the course of Information Retrieval has resembled the nurturing of an eighteen-year-old juvenile; during at least ten of his years parents and neighbors have been debating his genius versus his delinquency. On the one hand they nourish a hope that the young genius may solve some of the problems that have beleaguered the older generation; the problems, for example, of rigidity and obsolescence that are built into the hierarchical classification systems used in card catalogues. Yet on the other hand, they cannot believe that the fledgling of the library world, called Information Retrieval or "IR" for short, can be entrusted with these and other problems when he one-handedly drives a computing machine so wildly and expensively across the meandering highways of human communication.

The parents (traditional librarians) are not used to the budgets that these computing systems demand; they distrust machines and electronics; they look on the retrieval process as being naturally embedded in the total system of library operations, including acquisition, housing, item-retirement, and administration — as well as search services. For progress they still look to the kind of authority that was enthroned in the days of their collegiate training, in the representatives of which they have often perceived surpassing wit, insight, prudence, and unflagging commitment to the further subdividing and structuring of knowl-

The author acknowledges the significant and helpful suggestions contributed for this paper by his colleague, Joseph D. Chapline, Jr., of Philco.

edge. They have watched the first failures of the radicals who have applied various mechanizations to the library processes, and since they own no developed sense of the systems-power and depth of data-processor programming, they cannot see clearly how IR can be successfuly mechanized – least of all the "non-routine phases" of it.[1]

Yet they know that the world-wide flood of technical documentation is issuing at such an increasing rate that further mechanization is inevitable and imminent; that centralized IR is to be followed and indeed accompanied by decentralized mechanization, at first for special libraries, and soon after, for all kinds of collections anywhere. Almost everyone concerned has heard that the market for all types of IR equipment will have moved from $2 or $3 million in 1960 to about $100 million in 1965.

Meanwhile the insurgent information scientist has been gaining experience and developing his theories. He has come to appreciate more fully the subtleties of programming and operating electronic data processors. His sense of proportion as to the practical use of magnetic tapes and microfilm has been growing slowly and steadily. On the theory side he has found ways to index, abstract, and summarize technical documents automatically.[2] Out of his direct contact with high-speed computer memories he is revising the art of list-structuring in terms of associative micro-sequencing of those memories so as to get out from under the slow serial scanning methods of earlier efforts.[3]

In short, he has developed a healthy faith through practice, but he has failed to produce standard systems and standard operating procedures. Because the computing machines that were available to the information scientist have not been designed as complete IR systems, not a few information scientists have had to build a faith through hardship. To some of them, computers have offered little facility beyond the function of printing machines.

The neighbors would like to know when IR is going to settle down. What is it going to take to do the job? The key to the matter is the proper design of equipment. It is said that there is really no equipment required for IR that demands any fundamental technological breakthroughs. This does seem to be the case if we consider that equipment modifications, extensions and a few cases of new designs based on known techniques are all that are needed. There is a fundamental point of view required that commits the equipment designer to aim at the totality of library processing, on-line-with-the-user: designs which force the use of procedures of batching and piecemeal approaches, with segregated off-line mysteries in the computer room, are no longer tenable. In cooperation with the information scientist, who is the procedure specialist in the case, the equipment designer can provide the knowledge of engineering realizability and economic good sense. Eventually, all the major problems in equipment design and use will be resolved. How many of them bid fair to be resolved within *five years*? In what follows, we venture prognostications on the major stumbling blocks.

economic prospects

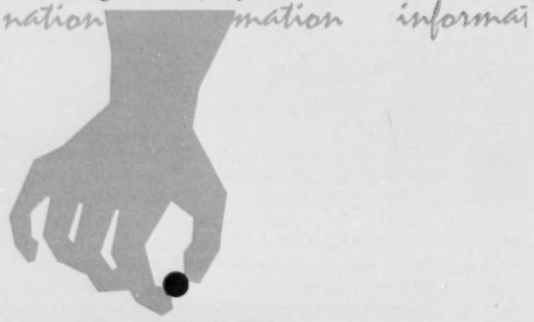
First, the key to the economic problem of supporting IR development lies temporarily in the intensity of interest of the national government in IR as a means of avoiding duplication in billions of r and d expenditures. There is already established a federal apparatus for underwriting some of the development of electronic information retrieval. This financial support is being directed increasingly toward new facilities, procedures, and basic information retrieval research (such as finding how scientists use their information sources,[4] etc.). A number of federal and civilian institutions are directly benefitting from this support as their retrieval services undergo mechanization. In turn, the data processing equipment makers are now able to custom design some of their product-line equipment specifically for IR.

Beyond this temporary stimulus, there will be strong and sustaining support once IR comes of age. The government will then insist that project proposals and project reviews commit contractors to determine the true state-of-the-art by means of IR as a condition for granting of contracts for advancing the state-of-the-art. To meet this demand, contractors will have to survey all relevant material *quickly* and *thoroughly*.

With continued dynamic development of IR mechanization, the cost per inquiry of shared multi-programmed computer processing will be measured in pennies.[5] Multiprocessing, now realized in many standard computers, makes possible the automatic interlacing of computer operations for a variety of problems, so that the prorated costs per IR inquiry can be very small indeed. It should be noted in this connection that the shared processor under executive program control can process many inquiries from different keyboard inputs, or a few inquiries plus several data processing or computing problems. The cost of the stand-by equipment to make this possible is the cost of on-line keyboards (ranging from teletype to flexowriter at about $5000 per instrument, at present-day, low-volume prices).

Coupled with this factor of economy are others which taken together are unusually significant. One of these is the general increase in the computer capability per dollar which has been shown to be not less than 300% every three years! Another factor is the achievement of low-cost, general-purpose computers such as the Philco 2400, the Honeywell 400, the IBM 1401, in which the cost of the buffering-hardware that connected the central processor to peripheral equipment has been almost completely absorbed. Still another factor is the enormous increase in speeds of memory which is being incorporated in the very latest designs for moderate-size processors, leading to still cheaper control and buffering logics. Finally the development of chained list-structure strategies for managing high-speed memories, discussed below, promises that each IR inquiry will entail only 2 or 3 memory cycles per item retrieved. Thus pre-sorting and batching processes are soon to be obsolete, and certainly uneconomical. Hence the older notion that inquiries need be batched for economy, which was true for the decade in which there were no techniques and equipment for multi-processing (and multi-input), can be laid to rest in this five-year stretch.

Based on these many factors, there is every prospect of sufficient economic support for, and payoff from, IR systems during the next five years.



query and rapport facilities

The *second* major stumbling block in the IR future during the next five years has to do with inputs and displays for the user. With respect to these, it should be noted that many military systems have incorporated multi-on-line inquiry and typeout instruments. Realizability is so advanced that a prominent eastern technical school is now

considering the acquisition of a set of instruments for a large classroom, one for each desk.[4] Furthermore, along with on-line type-out devices, military technology has brought to fruition several forms of multiple station closed-circuit TV systems, also techniques are now known for coupling closed-circuit TV directly to the data processor through standard radar-repeater tubes at economic rates ($5000 to $10,000 per instrument).

Why have we made the assumption that the scholar and technical worker need a "rapport facility" for their IR activity? The answer is that no one person, in almost any intellectual pursuit of today, can comprehend and contain within his own personal memory the total conceptual "vocabulary" that is relevant to his field. Therefore, he is always in need of probing the larger vocabulary—the library—of his own and allied fields. The trouble begins in attempting to match the specific inquiry to the vast resources of today's libraries. The complexity of today's technologies is so great that the libraries must be animated if they are to match the animation and needs of the workers in each field.

This concept of the animated library is new. It has been brought about by the development of high-capacity-storage devices, by the rapid processing ability of the modern electronic computing system, and finally, by the maturation of multiple input devices and multi-processing which permit simultaneous inquiries and multiple access to a single computer and file system.

Thus in the up-coming stretch of five years, the economic availability of on-line query and display instruments, leasable for about $100/month will soon constitute the necessary means of maintaining rapport between user and IR file. By this means the user may key-in an inquiry and subsequently receive from the processor, a typewritten or displayed list of relevant items. If such a list is too long, the processor will transmit its statistics and a list of descriptors suggested to specify more precisely and less voluminously, the subject field. After the inquirer receives a series of such approximations, a final appropriate list is developed for him automatically, in much the same way as he could be served by a well-trained librarian and bibliographer, – all in a matter of moments.

In the ultimate system, abstracts and summaries can be displayed, and finally texts, in the form of TV projections of microfilm. If the inquirer wishes hard copy, a xerograph reproduction could be formed *in situ*. Because the achievement of such services requires no new technology, but only system organization, it is clear that within the coming five years, such facilities can be so coordinated as to enable the user to remain *en rapport* with mechanized files, until by recursive questions he retrieves exactly what he wants. Other things being feasible, the widespread use of these query and rapport facilities will mark the transformation of mechanized IR facilities from a state of subsidization to a state of self-sustainment and resource.

automatic text transcription

Of course there are two kinds of input to an IR system. The one we have been discussing so far is concerned with the input and shaping of an inquiry from the user. The other input is the huge mass of text which must be incorporated into the "electronic files." The *third* bottleneck for the immediate future of IR is concerned with this kind of input.

It is known that the U.S. government will shortly be completely transcribing on a continuing basis, the bulk of significant foreign technical articles for purposes of automatic translation to English. In other words, these texts are to be available on magnetic tape that can be reproduced for any library or company. There is a serious need to reduce the cost of manual transcription (key-punching) of these masses of text material. Fortunately, for the objective of automatic input of printed material into computers, there has been recent heavy encouragement and progress in the development of character-recognition equipment. Capability for full-font text-reading is very likely to come through in another two years, and certainly in the next five. Digital fonts for bank checks and cash register tapes are handled fairly well at present. Special alphanumeric fonts for credit cards are also quite operational and widely used. Thus there is no doubt that in this five-year period continuous automatic input of raw text is and will be more accepted as standard procedure.

automatic indexing and abstracting

Why is it important that texts be transcribed into computer-readable form, when ultimately these materials are to be stored and retrieved for the user in the microfilm mode? The answer, fundamental for the successful mechanization of the total library process, is that the texts must be analyzed at high speed and with the programmed versatility of adaptive computer algorithms in order to be automatically indexed, abstracted, and summarized. In other words, the subject-headings that are relevant to each item that has been newly acquired for a document collection must be assigned *quickly, cheaply,* and in a way which corresponds to the *current* as well as *past* modes-of-inquiry in each field of knowledge. The user interest and the national interest are most critically concerned with *current* documents that can be retrieved from a collection, not with those that are available months or a year or so after authorship.

(Of course, the retrieval of older materials also has inestimable scholarship and tutorial values.) This is the *fourth* area of critical need in the IR field.

The cost of manual classification and abstracting of all the articles in the world's hundred-thousand technical periodicals would be fantastic. The practicality of carrying it out in a coordinated and timely way by manual methods is unrealizable. There is also a pressing need to extend the coverage to a myriad of unpublished working papers. Hence, there is an utter necessity for automatic indexing, abstracting, and summarization by electronic data processors. Only as raw text is available on some form of computer media, such as magnetic tape or computer-readable microfilm does the mechanization of the indexing process become feasible – and in as many forms as there are programmed systems to suit particular requirements.

How are these processes for mechanization of indexing to be made so feasible? The preliminary forms of the procedures that will be used have already been tried with amazing success and sophisticated improvements have been brought forth and carefully analyzed. Some of the concepts which they use are: (a) The formation of abstracts by retention of clauses having significant key words in context;[7] (b) The use of computer programs to form concatenations of other descriptors relevant to those descriptors which a user names in a particular query-action;[8]

(c) The formation of interest-profiles by questionnaires having suggested descriptors, plus places for nomination of new descriptors;[9] and, (d) Automatic table search by use of a chain of secondary keys.[10]

Because each of these important concepts has been well-supported by several easily available papers apiece, we will add underscoring only to the last two.

Of these two, the technique of forming interest-profiles is one of describing the long-term and/or short-term IR needs of a user by the same descriptorizing techniques as are used to index and descriptorize a document. The maintenance in a local computer file of on-line profiles of user-interests and subject heading thesauri can be exploited through the application of auto-indexing and auto-relevancy programming, to assist in or to directly provide the codification of items in the collection. Such interest-profiles also make possible the selective dissemination of copies of new items to appropriate users – just as is possible in the ASTIA system.[11] Similarly, through glossaries and relevancy chains of descriptors, these profiles-of-interest can be used, via a duality technique, to assist the worker in any search-for-novelty.

Part of the promise of success of these techniques lies in their flexibility and universality, while remaining relatively free from any doctrine of classificatory structurization. Part of their promise inheres in their dependence on human intervention. That is, the descriptorization of user-interests must come from the user himself; the mediation of the user is permitted at every moment during the on-line interrogation of the files. The abstracting experts, whose skills are so necessary in specialized fields, are provided full scope in mediating directly in the files of a system. Thus the future IR system never will exclude the product of human activity in the field of classification but will feed on it and augment it with automated abstracting when such is desired. It will be enabled to do this because concordances and interest-profiles can be programmed and maintained automatically with modern processors.

The ordinary library of today is a passive thing in which the operation is largely dependent upon how much time and ingenuity a given inquirer is willing to give to supply the necessary dynamism from himself coupled with the well-intentioned, helpful, but limited services of a librarian. The fault is not at all the librarian's, but is attributable mostly to the inability to be an expert with fine evaluating capacities in every field represented in the library. Cleverness, quick-wittedness and a prodigious memory are all valuable qualities in a librarian, but they merely cover up the basic problem that there is no substitute for the direct and specific knowledge of the inquirer himself. Therefore, the first requirement of the animated library is the help and cooperation of the inquirers even before the inquiries are ever made. The recent concept-developments in IR recognize the need for help from the user in the descriptorizing process. The universality of descriptorization is applied alike to documents and to user interests; the more a given person uses the IR-type library, the better will be the results for both user and the library.

associative memory

The control of computer memory to effect iterated cross-reference in a high-speed electronic processor is the domain of the *fifth* bottleneck in the IR future. Among the techniques we have mentioned above, is that of referencing the contents of a memory by a method called "table look-up," with secondary keys (e.g., that discussed by L. R. Johnson). There are several other methods worth mentioning and having unique merits: the list structures of Simon, Newell, and Shaw have led to such specializations for IR as the Gray and Prywes "Associative List Structures," (opus cit.). Independently Robert Ledley has developed the somewhat less redundant Tabledex method (opus cit.). All these methods incorporate some variety of *chaining*, i.e., of coupling a data-name with computer addresses of associated data. In E. Fredkin's TRIE memory, some micro-chaining (of word-parts rather than words) has been ingeniously formed. The author is interested in a general schema for chaining called SHIEF memory. All these constructs are useful in organizing normal computer memory into an effective instrument for "addressing-by-content," i.e., for recall of data when no knowledge is available as to the physical address or location of that data in the computer memory. Another phrase that refers to these modes of memory organization is "Associative Memory." None of these structures-concepts for attaining associative memory relies on special memory hardware such as cryogenic, multi-apertured or multi-coincident-circuitry arrangements. All of them operate on the assumption that search or "scanning" of any region of memory is to be minimized or eliminated. All of them assume that memory behavior is governed by small sequences of macro- or micro-programming. Any or all of them are realizable in physical hardware which has already been developed and tested in a wide range of computers; only the novel control circuitry (made of already available standard modules) is required for the proper sequencing. Thus there is every reason to expect that the IR processors, to be available during the next five years, will incorporate the basic facility of associative memory. With this facility, automatic associative cross-referencing, without the need for serial scanning, will have reached a critical stage of practicality.

memory capacity

The *sixth* bottleneck is the physical capacity of processor memories. Univac and others have already announced small workable magnetic film memories. There is every prospect that the total capacity of high-speed computer memory will markedly increase while cost decreases during the next five years. Thus all the required high-speed capacity for index cross-referencing and associativity is to be available. For retrieval of materials more extensive than indicia, namely abstracts and summaries, the newer disc memory devices should be expected to attain easily the necessary 300,000,000-character capacity levels in the coming half-decade.

But within the relatively short period of five years, it is too much to expect that film memory can be made so cheaply that it can be substituted for microfilm when storage of millions of pages of text are necessary even in small libraries. Furthermore, because whole pages must be quickly displayed during the browsing and rapport activities of the user, the slow, serial nature of locating an item on magnetic tape precludes the use of this medium for storing and displaying principal file items. Thus the techniques of microfilm reduction and non-serial locating, such as is used in an AVCO prototype[12] or in equivalent systems, seem most optimum. Here is indeed an area where present-day equipment is not adequate, and in which equipment manufacturers should endeavor to cooperate. Film companies should eschew the temptation to produce "integrated electronic systems;" electronic system companies should avoid producing high-cost, special film-handling systems. Here again is an area where no new technology is needed, only new systems aggregates of existing devices. With the right stimulation, five years should be sufficient to resolve the configurations that would have the somewhat obvious working requirements discussed above.

communication linkages

The *seventh* bottleneck is due to fade away fairly steadily.

It is concerned with the need for the IR user to work with the computer over the telephone (on the one hand) and directly with the computer while it works with files and computers in other libraries and plant locations (on the other hand). Already communication facilities such as Bell System's Dataphone equipment make this possible. Military message centers under the monitorship of digital data processors such as Philco's DCA surveillance system also are examples of the workability of existing technology in satisfying this basic IR need. Pacing the use of telephone lines within metropolitan areas is the onrush of economic microwave devices available to any customer with optically-uncomplicated paths between plants.

specific implications for equipment

In the foregoing we have surveyed the five-year prospects of progress in adapting data processing systems to the work-a-day needs of the user of information retrieval services. We have probed the cost picture, the input-display-rapport facility, the problem of mass-text-transcription, the techniques of automatic indexing and abstracting, the means of high-speed cross-referencing (avoiding serial search) in the form of associative memory, microfilm memory for texts and display, communication devices on-line between man and computer, and between computer and computer.

In every case a step-up in capability in one of these areas adds to the overall effectiveness of devices in the other areas. We have seen that there is every prospect that progress in each individual area in five years will be sufficient to go over the top, i.e., to bring mechanized IR into a state of self-sufficiency and of resource from which benefits will pour into business and science.

There are two courses which industry and government can follow which will ensure and expedite this progress. The first is the encouragement of new EDP product forms, which, serving the established EDP market, can be simply accommodated to IR devices, without high-cost custom engineering. This encouragement should pay off doubly because in almost every instance coupling of so-called IR devices, such as inquiry keyboards and displays and on-line communication linkage, are needed everywhere for normal EDP process functions. The key to this first course is that the EDP manufacturer must simplify and standardize his buffer-linkages between control processor and special devices. The second course is the intensive encouragement of human techniques of index-assignment, interest-profiling, text manipulation, and relevancy and citation analysis – working with the full scope of programming and process-simulation techniques afforded by the modern electronic computers. Automatic programming should be developed for these IR simulation activities. The human beings to be encouraged here above all should include the many seasoned work-a-day librarians who are willing and able to learn and practice computer programming for at least a year of internship.

Without these approaches, the course of mechanized IR may be a muddling bumble for many years. With these approaches, equipment manufacturers and users can cooperately develop effective, flexible, standard operating procedures and devices in five years. Then in truth we can hope to add to the twentieth century's many laurels the achievement of on-demand retrieval of human knowledge and recorded activity, any time and anywhere. ■

Ben Cheydleur joined Philco in 1960. His primary responsibility has been the integration of programming and computer design, with special emphasis on the organization of memories for IR, and in the linguistic requirements for the service of IR systems. He was formerly manager of advanced programming for RCA's EDP division and manager of systems planning for RemRand Univac, as well as a charter member of the Dept. of Defense CODASYL committee.

NOTES

[1]For an information scientist's "go-slow" point of view, see Bar Hillel, "Some Theoretical Aspects of Machine-Literature Searching," TR #3, April 1960, Hebrew University, Jerusalem, sponsored by United States ONR and NSF.

[2]*For theory*, see for example, C. N. Mooers, "The Application of Simple Pattern Inclusion Selection to Large-Scale Information Retrieval Systems," *Tech. Bull. 131*, April 1959, AD-215,434. Zator Co., Cambridge, Mass.; "A Mathematical Theory of Language Symbols in Retrieval," *Proc. International Conf. on Scientific Information*, 1958; R. A. Fairthorne, "The Problems of Retrieval," *Amer. Doc. 7, #2* (April 1956), 65-75.

For evaluation, see for example, C. N. Mooers, "The Intensive Sample Test for the Objective Evaluation of the Performance of IR Systems," *Tech. Bull. 132*, Zator Co., (Aug. 1959); M. E. Maron, "Automatic Indexing: An Experimental Inquiry," *J. ACM 8* (1961) 404-417.

For automatic abstracting, see for example, H. P. Luhn, "The Automatic Creation of Literature Abstracts," *IBM J. Res. and Dev. 2, #2* (April 1958), 159-165; "Keyword-In-Context Index for Technical Literature," *Am. Doc.* 11, 4 (Oct. 1960) 288-295.

[3]See, for example, J. C. Shaw, A. Newell, and H. A. Simon, "A Command Structure for Complex Information-Processing," *Proc. WJCC*, (May 1958) 119-128; H. J. Gray and N. S. Prywes, "Outline for a Multi-List Organized System," *14th Natl. Mtg., ACM* (Sept. 1959); R. S. Ledley, "A New Coordinate Indexing Method for Bound Book Form Bibliographies," *Proc. of International Conference on Scientific Information*, 1958.

[4]A similar study of this kind is reported by Saul Herner, "The Information-Gathering Habits of American Medical Scientists," *Proc. International Conference on Scientific Information*, 1958, op. cit., p. 277.

[5]See for example, the costs cited three years ago by Opler and Baird in "Developing Retrieval Systems on Large Computers," Proc. International Conference on Scientific Information, Wash., D.C., 1958, National Academy of Sciences, page 701; costs cited here should be reduced further, as they were based on batching methods.

[6]Increasing awareness of the natural role of on-line IR facilities for educational purposes is bound to accelerate the demand for automatic IR equipment.

[7]M. E. Maron and J. L. Kuhns, "On Relevance and Probabilistic Indexing and Information Retrieval," *J. ACM 7* (1960), 216-244; H. P. Luhn, *opus cit.*

[8]H. Edmund Stiles, "The Association Factor in Information Retrieval," *J. ACM* (April 1961), 271-279.

[9]C. K. Schultz and C. A. Shepherd, "The 1960 Federation Meeting—," *Federation Proceedings*, (July 1960), 682-699; H. P. Luhn, "Business Intelligence Systems," *IBM J. of Res. and Dev.* (Oct. 1958).

[10]H. J. Gray and N. S. Prywes, opus cit.; R. S. Ledley, opus cit.; L. R. Johnson, "An Indirect Chaining Method for Addressing on Secondary Keys," *Comm. ACM, 4, 5;* (May 1961), 218-222.

[11]The pertinence of interest-profiles can be augmented by the automatic accumulation of requestedness statistics. Also with such statistics, the continual up-to-date maintenance of the most actively demanded materials in the higher-speed areas of processor memory and the orderly retirement of inactive materials to discs and tapes can be carried out.

[12]Holding 100 x 100 pages on one square foot of film and a set of 100 such pages in approximately a cubic foot; incorporating direct mechanical and optical selection for projection.

COMPROMISE — A KEY TO DOCUMENTATION

Western Reserve reports on i.r. studies

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The Center for Documentation and Communication Research at Western Reserve is engaged in the operation and development of mechanized systems of information retrieval in the physical, natural, and social sciences. Under sponsorship of the American Society for Metals, the Center is operational in metallurgy and allied subject fields, providing bi-weekly searches of over 1500 current metallurgical abstracts, and retrospective searches of over 70,000 metallurgical abstracts (1958-1961).

Research is also underway on the application of machine methods of storage and retrieval to the literature of communicable diseases (sponsored by the National Institutes of Health), of diabetes (sponsored by the American Diabetes Assoc.), and of education (sponsored by the U.S. Office of Education). Funds have also been provided by the Air Force for the development of a fundamental theory of documentation.

Writing about the Center for "Datamation," we were sorely tempted to describe in detail our computer-oriented activities – the old Western Reserve University Searching Selector and its wired program, and the GE-225 and its stored programs. Although the reader might expect the hardware aspects of our program to be the controlling element, this is not the case. This article proposes to deal with the often neglected "human side" of information retrieval and the numerous compromises necessitated by this activity.

Three major areas exist in which human beings play either a solo role or a strong supporting role: the selection, processing, and searching of recorded documents.

Selection of documents immediately poses two problems. To a philosopher who holds himself aloof from practical affairs, the storing of knowledge may be an end in itself, however the decision to retain or destroy something is a difficult one, for it requires a prediction as to when stored knowledge will be replaced by newer material. This is the first problem faced in selecting documents: is the material chosen going to be of continuing interest? The second problem is that of setting the limits of one's selection. In 1958 with the cooperation and support of the American Society for Metals, the Center applied itself to organization of a mechanized IR system in the field of metallurgy. But what is metallurgy? As a first step, the Center, in cooperation with ASM's Documentation Committee formulated a definition:

> **"Ore processing; extraction and refining; iron and steelmaking; foundry practice; forming and shaping operations; matching (where metallurgical nature of tool or work-piece is involved); powder metallurgy; heat treatment; welding, cleaning, coating and finishing for other purposes than for mere decoration; metallography and primary structure; phase transformations; physical and mechanical properties; corrosion; inspection and control; metal products and parts; plant equipment in relation to metallurgical processes; metallurgical education and history."**

Any definition is bound to be arbitrary, and this is no exception, and it does represent compromise, albeit collective thinking. About 300 journals were selected which satisfied this definition. So far, so good. But many articles of interest to metallurgists, appear in the journals of physics, inorganic chemistry, geology, etc. Under a grant from the National Science Foundation, arrangements were made with the John Crerar Library of Chicago, for scanning these peripheral journals. Frequently, however, articles selected from these journals did not quite meet the previously established definition of metallurgy. One question has to be asked repeatedly, "Is this metallurgy?" No one at the Center could come to any definite decision, so abstracts of articles in a number of questioned areas were submitted to the ASM's Documentation Committee. The Committee, composed of experts in the field of metallurgy, was asked to decide if the topics covered by these abstracts were appropriate to the Center's service. Out of 48 abstracts submitted, only six received unanimous yes or no decisions, 11 were split right down the middle (equal number for and against), and the rest presented a difference of opinion that was at least significant. Com-

promises obviously had to be made, and were made, to give the Center a working solution to the problem.

Compromise again is a major factor in the second area, processing. Processing can be divided into three decision elements: selection of abstracting method, depth of document analysis, and control of terminology.

In evaluating these elements, let us start with a practical consideration: retrieval systems – especially machine systems – have been developed, or are under consideration, because it is "impractical," inconvenient, or too expensive to locate desired records from a file by other means. Usually the "size" of the file (as measured by the number of records, depth of analysis of each record, and complexity of subject matter covered) has reached the point where an existing retrieval system is not expected to provide adequate service in response to the average inquiries.

When such a situation exists, it may be assumed that the number of records being incorporated into the file exceeds the ability of a potential user of the information it contains, to read and to remember the contents of every record that is incorporated. When this situation has been reached, then for any record that is to be analyzed for retrieval purposes, it cannot be assumed that a person who may later want to see the record will have read it previously or even have seen it before. In these cases, requests for records containing desired information will be based on clues, subjects, or verbalization of subjects which are probably drawn from the requester's background and *not necessarily from the text of records stored in the file*.

Now, when graphic records are to be stored away for potential retrieval at a later time, two decisions must be made by the analyst of the record:

(1) Which aspects of the record are of probable importance to potential users?

(2) How should these aspects be expressed in the retrieval system so that there will be a good probability of matching the way potential users will think of and express their requests?

In order to cope with both of these questions an abstracting system, known as the "telegraphic abstract," was developed at the Center. Using this system, words which express the contents of the article being abstracted are written on a standard form, grouped by punctuation symbols (in much the same way as ordinary punctuation groups words in natural language), and identified as referring to a material being processed, a process, a product, a major and minor component of an alloy, etc., by a role indicator code.

The second segment of processing, depth of document analysis, also requires that compromises be made. The Center knows very well that it is impossible to put *all* the information in an article on tape, and ready for searching. Even if it were possible, it would still be very difficult to satisfy every potential user of the system by giving implications of the article, bias of the author, etc. During the pilot operation of the metallurgy program, users were asked to comment on such things as:

(1) Pertinent references received were satisfactory. If unsatisfactory, why?

(2) Marginal references were either of interest or of no interest in connection with the question asked. If of no interest, why?

On the basis of user comments, decisions were made as to how deep to go in analyzing articles to satisfy the user's needs.

Somewhere along the line the terminology of the system must be controlled. A number of approaches to the problem are possible. A thesaurus of terms can be assembled, making it possible to determine what terms have aspects in common. The basic drawback to a thesaurus is its inaccuracy: it does not accurately show differences between terms, nor does it accurately show which aspects the terms have in common. Another approach is used by the Center. A code dictionary has been developed which not only shows broad generic relationships between terms, but also pinpoints any differences that might exist between them. It is, once again, a compromise having the advantages of a thesaurus, and the advantages of a dictionary in that it gives accurate, specific definitions. For example, the term thermometer has the

Abstracting at Western Reserve: compromise and a healthy distance from automation.

code MACH MUSR RWHT. The first, third and fourth letters in each group make up what is called the semantic factor. M-CH refers to device, M-SR to measurement, and R-HT to heat. The alphabetic infixes in each semantic factor, A, U, and W tell us that it *is* a device, it is *used* for measurement, and it *refers* to heat. In addition, a number may be added to any of the semantic factors, e.g. MACH 1002, more closely defining that factor. An end number is then assigned to the whole code, identifying specifically the particular term. Thus with the dictionary, it is possible to identify broad generic relationships and at the same time to be very specific. The dictionary for metallurgy at the Center now contains over 30,000 words. It is being added to at the rate of about 180 new words for every 1000 documents processed. A saturation level is being reached, but with the constant coining of new terms and the increase in scope of the program, a true saturation point will probably never be reached. The coding of these terms is a human operation, and a result of compromise thinking.

These human operations are supported by a mechanization of routine activities. After 60 part time personnel have made abstracts of the articles (over 750 a week) and these abstracts have been edited by metallurgy specialists, the information on the telegraphic abstracts is keypunched on IBM cards. The cards are then alphabetically sorted, coded by matching with the metallurgical dictionary (also on IBM cards) and recorded automatically on magnetic tape. Keypunching, sorting, comparing, and recording, being machine operations, take less than a day for 100-150 abstracts. The computer then searches very rapidly for document references to questions asked. Significant human endeavor is a preliminary to all of these operations.

The third major area, searching, also requires a considerable amount of preliminary human endeavor. Questions submitted by the users must be coded using the metallurgical dictionary. At this stage we must try to determine exactly what the client wants. The questions are then structured logically, using a Boolean function, in three basic ways. It is possible to identify all of a group of characteristics (the logical product), e.g. A·B·C·D·E, or to identify documents characterized by any one of a number of characteristics (the logical sum), e.g. A+B+C+D+E, or to identify documents that have one characteristic and not another (the logical difference), e.g. A-B. More complex relationships can be programmed for the computer that utilize combinations of any of the above, e.g. [(A·B) + C] [E-D]. Using these three basic approaches, or combinations of them, an initial search is conducted, after which experimental searches are made by rephrasing the original question, in an attempt to narrow the search results.

Search results are then thoroughly analyzed in terms of "has the user's question been satisfactorily answered?" The question is compared with the conventional abstracts of the documents retrieved, and if more detailed analysis is needed, it is compared with the telegraphic abstracts of these documents. The Center wants to know, too, why the computer picked out a particular document in answer to a question.

The original hardware for the searching activity was designed and constructed at the Center. The Western Reserve University Searching Selector was designed to perform the following operations:

(1) Record sequences of symbols (coded items from the telegraphic abstract) on punched paper tape.
(2) Read the punched paper tape and convert the patterns of holes into corresponding patterns of electronic pulses.
(3) Select characteristics and combinations of characteristics of documents, that refer to a particular question asked.
(4) Type out automatically the identifying numbers of those documents whose characteristics correspond to the characteristics of the question.

It was soon recognized that the capabilities of the searching selector were being outdistanced by user demands.

Because of the need for a faster more efficient machine, bids were asked from various companies for the development of a high speed searching device. A contract was made with General Electric to build the GE-250. After some exploratory work, it was decided that the GE-225, a general purpose computer, would be more suitable for the Center's needs, and the 225 was delivered in April 1961. The installation at the Center has a core memory of 8,000 words with two magnetic tape handlers. It is equipped with a 400 card/minute card reader, a 100 card/minute punch output, and a typewriter. Its 18 micro-second fetch time provides capability for all our foreseeable needs. Altogether the computer has provided the means for getting immediate results, some basic problems still have to be solved.

One of these problems deals with the meaning of words. To an Englishman, a car fender is a "wing," a hood is a "bonnet," etc. Our code dictionary handles this type of relationship quite adequately. But words like "scale" present problems. What is a scale? Does the word refer to a mark along a line, the proportion that a map bears to the thing it represents, a series of tones arranged in a sequence of rising or falling pitches, the scale on something, e.g., a fish, or a flaky film, an oxide on a metal, or a balance? To be sure, one of the subjects with which we deal is metallurgy, but even within such a field, the possibility of a variety of meanings for one word is extensive. To give us some help in solving this kind of semantic problem, a series of word association tests was constructed.

Three tests are presently administered in a battery to university personnel. However, an application of such a test to the users of the Center's system, might provide some insight into how the user thinks about various words and word classes. The first test is a free association test, that is, give the word that comes first to your mind after having read a given word on a list. In the second test, a word has to be supplied that might serve as a heading over a given example (generic classification), e.g. if the word given were trout, one might supply fish. The third test requires that a word be supplied that is an exact synonym of a given word, e.g. for molybdenum one could supply moly, or possibly Mo. This "word" problem is perhaps one of the most difficult to be solved, and certainly one of the most important.

Another problem is the formation of a fundamental theory of documentation. Under an Air Force grant, work is progressing toward a mathematical theory of documentation. Jacobus Verhoeff (who visited from The Netherlands), Jack Belzer and Dr. William Goffman, of the Center's staff, have done some pioneering work in this area. It is hoped that their work will lead directly to improvement in methods of searching, document analysis, and to an increase in the general efficiency of the system. The necessity for basic research in the development of information retrieval theory is absolutely necessary, because to a large extent, the technology has outrun the system.

The problems encountered in a machine literature searching service are directly analogous to the problems in business and scientific research. A great deal of hardware is available, but the real problems are human problems. ■

AUTOMATING IR INPUT

an evaluation of progress in linguistic data processing*

by PAUL L. GARVIN, Thompson Ramo Wooldridge Inc., RW division

Language data processing can either serve linguistic ends, as in *automatic linguistic analysis*, or more practical ends, as in the fields of *machine translation, information retrieval, automatic abstracting*, and related activities.

The criterion for an evaluation of content in the case of information retrieval seems to be the comparability of each particular document to those of a related set, in order to ascertain the common features and differences that can serve as a basis for an index in terms of which information can be retrieved in response to a request. In automatic abstracting, the evaluation is one of various portions of the document with regard to each other, in order to ascertain what portions are significant enough to be retained and what portions should be omitted.

At present, language data processing activities are required to use the conventional input mechanisms of punched card, punched paper tape, magnetic tape, or the like. This is generally considered to be a major bottleneck in terms of practicality since the cost, especially for the large quantities of input that are desirable for eventual production, is prohibitive. A good deal of effort in various places is therefore directed toward automating the input.

In line with the two substances in which the sign components of language are usually manifested—the phonetic and the graphic, these efforts proceed in two directions: *automatic speech recognition and automatic character recognition*.

The problem with speech recognition is one of identifying, within the total acoustic output of the human voice or its mechanical reproduction, those elements which are significant for transmittal into the internal phase. The difficulty of the problem becomes apparent when one realizes that most phoneticians agree that only a small portion of the total energy in the human voice ouput (some claim as little as 1%) is utilized for purposes of the linguistic signal proper. The remaining energy serves as a signal for such nonlinguistic elements as the identification of the sex and individuality of the speaker, his state of health (whether or not he has a cold), his emotional state, and a large number of other behavorial indices. Thus, the acoustic power available for purposes of speech recognition appears to be rather small. The significant fact is that this small percentage tends to be masked by the rest. The second difficulty is that the natural vocal signal is semicontinuous. That is, the number of physically observable breaks in the continuity of speech is much smaller than the number of discrete elements into which the signal is decomposed in either alphabetic writing or linguistic analysis.

Speech recognition experiments so far are largely limited to the perception by machine of short, isolated stretches. Even in this limited framework, progress has so far resulted in the identification of only some of the gross acoustic features, such as the break between syllables, the friction component of certain consonants and the voicing component of vowels and certain consonants. More refined identifications can be expected as acoustic research progresses, and an adequate capability for identifying isolated phonetic stretches is achievable along lines presently being pursued.

Not much attention has been given to the recognition by machine of the interruptions in the continuity of the stream of speech that linguists call *junctures*. Linguistic and acoustic research on the phonetic characteristics of junctures will undoubtedly contribute highly to this aspect of speech recognition.

The problem of character recognition is by comparison somewhat less complex, because—unless one thinks of a device that is intended to recognize handwriting—the visual input in the device is discrete; that is, it can be expected to consist of separately printed or typed letters or characters. Thus, the very difficult speech recognition problem of recognizing the boundaries of stretches within a semi-continuous signal does not exist for character recognition. On the other hand, the problem of recognizing what particular features of the signal—in terms of strokes, angles, curves, directions, and the like—are relevant to the function of the character is similar to the problem of recognizing the linguistically relevant acoustic features of speech.

Where linguistics does have a contribution to make is in the recognition of poorly printed or otherwise unrecognizable characters. There, the gaps in the recognition string will have to be filled by a context searching routine similar in principle to that required for speech recognition.

A fundamental difficulty in character recognition is the variety of fonts that are used in ordinary print and typing. Apparently, devices which are limited to a single font—particularly if that font has been specifically designed to facilitate the operation of the device—are now in an operational stage.

Devices which can deal with a multiplicity of fonts, particularly fonts with which the device has had no prior "experience," are still in their infancy. Some experiments have already yielded data about those characteristics which different fonts have in common and upon which a common recognition routine can be based, and work is in progress on the particular perceptive mechanisms which could serve to recognize these characteristics. Workers in the field of character recognition are therefore more sanguine about impending success than workers in the field of speech recognition.

In the process of translation one possible linguistic expression of the same content is replaced by another. To mechanize the process, the recognition of the content in its first expression—the *source language*—has to be mechanized, and only after this has been achieved, can the command be generated to give the same content another linguistic expression—in the *target language*. In practical terms this means that a machine translation program has to contain a *recognition* routine to accomplish the second. It is equally clear that the command routine presupposes the recognition routine and therefore, for purposes of machine translation, a "recognition grammar" of this sort is more essential than a "generative grammar."

In order to effect the recognition of the content of the source document, the machine translation program has to take into account, and can take advantage of the structural properties of the language in which the content is originally expressed. First of all, the program has to ascertain what content-bearing element is represented by each letter combination (that is, printed word be-

*This is a condensed version of a paper soon to appear in "Natural Language and the Computer," Paul L. Garvin, ed., in press with The McGraw-Hill Book Co., Inc., New York. This report was prepared exclusively for DATAMATION.

tween spaces) that has been sensed at the input. This and the subsequent tasks are accomplished by providing the program with a *machine dictionary* and a *translation algorithm*. It is no longer necessary at the present state of the art to stress that in order to produce a non-ridiculous translation, a program must contain not only a dictionary but also an algorithm. The function of the algorithm is dual: it must select from among several possible dictionary equivalents that which is applicable to the particular sentence to be translated, and it must achieve the rearrangement of the words of the translation whenever necessary in order to give the appropriate expression to the content of the original. To make possible the generation of these selection and rearrangement commands, the algorithm must be capable of recognizing the syntactic and other conditions under which these commands are necessary and appropriate. For this recognition to be effective, the grammatical structure of the language has to be taken into account.

The field, of information retrieval and automatic abstracting, differs from machine translation in that it requires in addition to the recognition of the content of the document, its evaluation from the standpoint of some relevance criterion. Evaluation in turn implies comparison of elements in terms of this relevance criterion; such a comparison then presupposes some orderly classification within the frame of which units can be selected for their comparability.

At the input of an information retrieval system is the user's *request for information*. If this request is phrased in natural language, it will have to be processed for transmittal to the internal phase. Systems in which the request is either stated in some *standardized language* or is reformulated manually, will thus not require language data processing at this point.

The internal phase of a retrieval system consists of information from which to select portions relevant to the request, for display at the output end. The ordering system used for the storage of this information can be called a system of *indexing*, since it is comparable in its purpose—though not necessarily in its structure or efficiency —to the index of a file or library. This indexing system can be prepared manually, in which case only the actual searching operations within the memory are automated; if it is not prepared manually, that is if the system is equipped for *automatic indexing*, natural language has to be processed. In this case it is the natural language of a series of documents, the informational content of which is to be stored in the memory.

Automatic abstracting by the nature of the process, uses documents in natural language at the input and the system thus has to be capable of recognizing content indices in natural language text in order to yield at the output the required condensed representation.

It is again possible to divide this automatic process into a recognition and command phase. If this is done it becomes apparent that the automatic processing of the natural language of informational requests, natural language documents for indexing, and natural language documents for abstracting, all fall under the same heading of recognition operations. We might add that the requirements for a recognition routine are sufficiently similar for the three activities to be discussed together. Where they differ is essentially in their command routines: the command routine for the processing of the request will have to include commands for translation into a search language to be used during the search. In automatic indexing the command routine will have to consist of commands for the storage of portions of documents in appropriate memory locations corresponding to the *indexing terms* under which they can be retrieved during the search. In automatic abstracting finally, the command routines will have to consist essentially of accept and reject commands about individual sentences, if—as is the case at the present state of research—abstracting is essentially an activity of extracting.

It is possible that in the future, an automatic abstracting system may be capable of rewording the sentences extracted for retention in the abstract by generating natural language text on its own, to approximate more closely human abstracts which have certain characteristics of continuity and readability that are absent in simple extracts. This particular final phase of automatic abstracting is the one area of language data processing in which at present I can visualize a genuine practical method of machine sentence generation.

Let me now discuss a linguistic perspective on the language data processing problems involved in the above. The major purpose of this processing is the recognition of content for purposes of comparative evaluation. The program must ideally be capable of doing two things: it must recognize an individual *content element* in the natural language text (a single word or a relevant combination of words, and it must be able to decide on some comparability criterion for each of the content elements that it has found.

In order to meet the first of these requirements, the program will have to include some features comparable in nature to those of the algorithms used in machine translation. I am referring to the need for something like an *idiom routine* to recognize word combinations that represent single content elements, and also the need for some provisions for the recognition of the syntactic units and relations relevant to the objective.

It is in regard to the requirement of *content evaluation* that an algorithm for content processing will differ most radically from that for machine translation.

In order to arrive at a comparison of content elements to each other in terms of some relevance criterion related to the goal of the operation (processing of the request, assignment to index terms, acceptance or rejection for the extract) these elements must be classified in terms of the content which they represent, rather than in terms of their formal co-occurrence characteristics. This means in practical terms, that in addition to a grammar code comparable to those used in machine translation, the ideal dictionary for content processing will have to include a semantic code which can refer each dictionary entry to the appropriate area of content representation; that is, to the semantic class to which it belongs. For optimal efficiency such a semantic code ought to be based upon a systematic classification of content elements. Classifications of a kind can be found in existing thesauri and partial classifications can be found in synonym lists. There are two major defects in thesauri of the Roget type: they usually do not contain enough of the technical terminology required for most practical content processing purposes, and more serious from a linguistic standpoint, is that they are compiled purely intuitively on the basis of some underlying philosophic assumption and do not necessarily reflect the intrinsic content structure of the language which they represent. Similar criticisms can be brought against most synonym lists.

The assumption implicit in these criticisms is that there might exist for each language a system of content comparable to the formal system that linguists deal with when they treat the various levels of a language.

It is thus possible to envision a systematization of content, or meaning, not unlike the systematization of linguistic form for which today we have the capability of developing. ■

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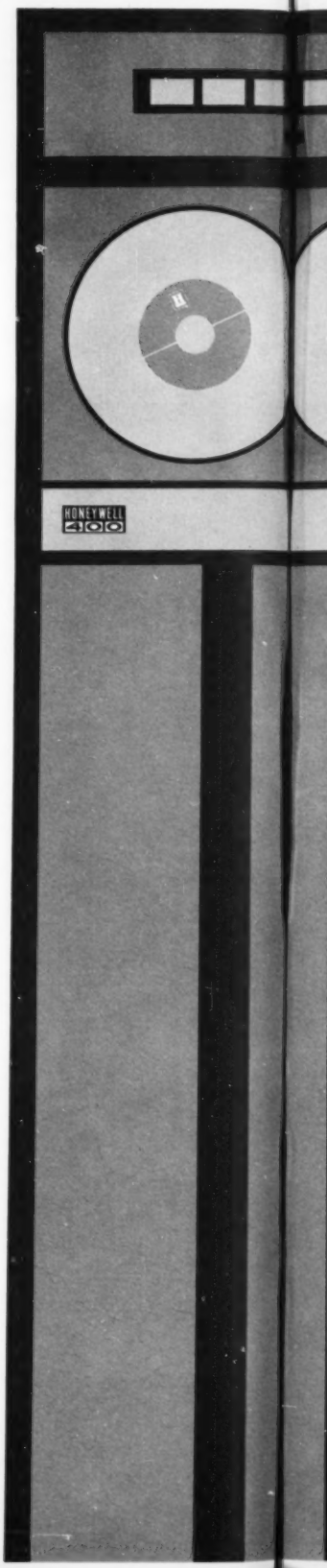

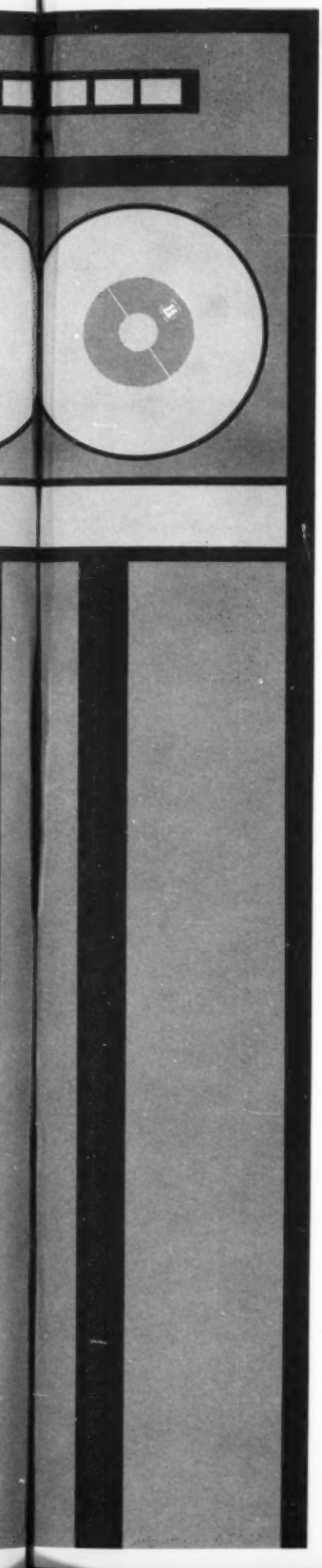

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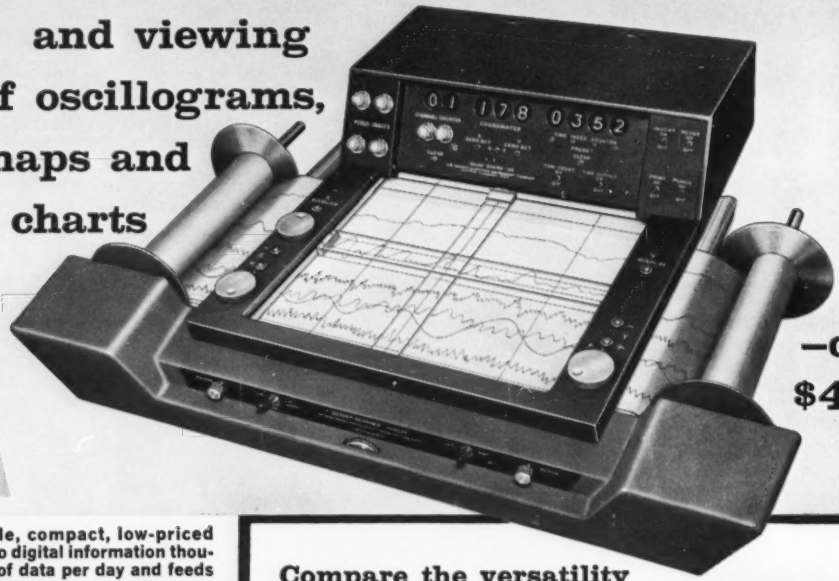

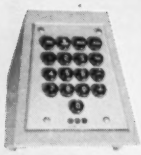

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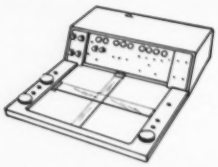

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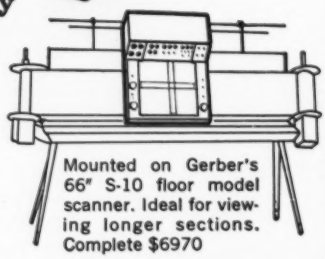

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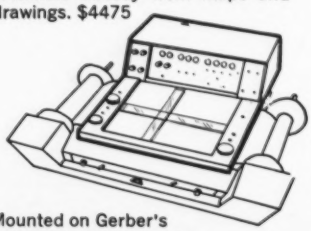

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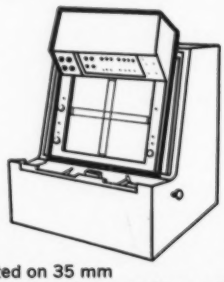

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CIRCLE 15 ON READER CARD

1961 EASTERN JOINT COMPUTER CONFERENCE

record-breaking attendance expected

A record-breaking attendance of almost 4,000 industry delegates is expected for the 1961 Eastern Joint Computer Conference which opens in Washington, D.C., December 12. (A special issue devoted to the EJCC will be featured next month in DATAMATION.)

Keynote speaker for the conference will be D.L. Bibby, president of Remington Rand whose address will follow the overall conference theme, "Computers – Key to Total Systems Control."

Out of a total of 242 submitted papers, 31 have been selected for the program following one of the most intensive reviews in conference history. Proceedings will be published in a cloth-bound edition by the MacMillan Co. and will be made available three days prior to the opening of the conference.

The papers selected cover a wide range of subjects and almost all may be classed as being of unusual interest. For example, during the first session, to be held on the afternoon of Tuesday, the 12th, and entitled "Total Systems in Real Time," G. G. Chapin and R. A. Hileman of Remington Rand Univac in San Diego will discuss the Naval Tactical Data System (NTDS), in connection with which over 250,000 instructions were produced for the first two phases of system development.

A four-section paper on the Project Mercury real-time computational and data-flow system will be offered by S. I. Gass, W. K. Green, J. E. Hamlin, R. Hoffman, R. D. Peavey, A. Peckar and M. B. Scott of IBM Federal Systems Division, Washington, D.C., during this same session.

The "Systems Simulation" session on Wednesday morning, the 13th, will feature the presentation of five papers, the last one of which seems bound to arouse widespread interest if only because its author is 16 years of age. David Malin, a student at Walter Johnson High School, Rockville, Maryland, has won a place among the elite of the computer fraternity with "CONTRANS" (Conceptual Thought Random-Net Simulation). As described in the abstract, CONTRANS is a computer simulation of a physiologically-oriented reasoning and problem solving model.

A panel discussion of programming language standardization will be featured for the Wednesday morning session. Participants will include C. A. Phillips of the Defense Department; A. J. Perlis, Carnegie Tech; R. E. Utman, Remington Rand Univac, and R. F. Clippinger of Minneapolis-Honeywell.

Described by one conference official as a "compendium," the Wednesday afternoon session – "Advances in Equipment" – revolves around meaningful advances in the field of hardware, as viewed by both large and small manufacturers. Included is a paper to be offered by T. Ishedate, S. Yoshizaka and N. Nagamori of the Nippon Electric Co., Ltd., Kawasaki, Japan. The Far East delegates will dwell on the characteristics of "Eddycard Memory – a Semi-Permanent Storage."

Thursday, the 14th, stresses "Communications Systems" during the morning session "Programming and Applications" is the subject for the closing session Thursday afternoon.

The 1961 EJCC will probably break exhibit records as well as attendance figures. In floor space, more than 11,000 square feet have been secured in the Exhibitions Hall of the Sheraton Park Hotel, 500 feet more than at last year's EJCC. The number of firms exhibiting have also increased. At least 75 different companies will show their wares at the conference while at the WJCC held in Los Angeles earlier this year, there were 60 exhibitors.

To accommodate prospective exhibitors, John Whitlock, exhibits manager, has arranged for additional space. Full frame manufacturers have been allocated 75 of the booth units for 20 exhibits. In general, the emphasis has been placed on "live hardware."

Whitlock is confident that the 1961 EJCC will make considerable new-product news in the computing industry. In a number of cases, his request for information on precisely what equipment is to be shown has been met with the apology that the manufacturer in question is not yet ready to make that disclosure, along with the implication that elements of the exhibit are making their debut at the conference.

An additional day, Friday, Dec. 15th, has been set aside for a special presentation of the EJCC exhibits to government personnel, arranged by the Bureau of the Budget.

At present, the schedule calls for installation of exhibits to begin at 8 a.m. Dec. 10, with the opening of the Exhibition Hall set for 11 a.m., Dec. 12th.

The Sheraton Park Hotel (still known to some diehards as the Wardman Park) is approximately two miles from the White House, north along the axis of Connecticut Avenue. ■

EJCC PROGRAM COMMITTEE: Seated (l to r): Charles Phillips, Office of the Secretary of Defense, Washington, D.C.; Dr. Jack Moshman, vice president of C-E-I-R, Inc., Arlington, Va., General Chairman of the Conference; Bruce G. Oldfield, IBM Federal Systems Division, Washington, D.C., Program Committee Chairman.

Standing (l to r): Paul W. Howerton, Central Intelligence Agency, Washington, D.C.; Solomon Rosenthal, Headquarters U.S. Air Force, Arlington, Va.; George Heller, IBM Federal Systems Division, Washington, D.C.

ACM CONFERENCE REVISITED

profits, progress and intellectual dignity

As a direct result of a major shift in ACM conference policy, the association's 16th national conclave held last month proved that the change was a highly profitable one and that intellectually, there was only minor suffering attributable to crasser but pleasantly lucrative motivations.

For the first time an ACM national conference was not held at a university campus but at the Statler Hilton Hotel in Los Angeles. Attendance was estimated at more than 2,300, almost triple the registration at last year's Milwaukee conference during which 920 attended.

For the first time exhibits were premitted at an ACM show and 35 suppliers occupied 55 booths at a profit to ACM at least double that of any other year; in fact, if it were not for the exhibit money, ACM may well have registered a tidy financial loss for this convention.

Still another "first" was the fact that there were no serious grumbles as to the content of the papers presented while on the contrary, there were a number of well-placed bouquets for some impressive contributions to knowledge. Attendance at almost every session (particularly the evening tutorial meetings on ALGOL and COBOL) was excellent. Program chairman J. H. Wegstein was responsible for such innovations as the tutorial sessions, the initial opening session at which highlights of the industry were tersely presented, the panel discussions on university education, the JUG-sponsored discussion, etc.

Of special note was the attention provided for the local and national press which was treated to a three-day battery of well-planned and informative conferences resulting in some of the most favorable reporting which the computing profession has yet received. Publicity chairwoman was Phyllis Huggins.

Not without its negative aspects however, the ACM conference once again offered far too many papers in too short a period of time. Functionally, there were obvious weaknesses such as speakers scribbling on blackboards before eye-straining audiences of several hundred, and presentations in monotone-ridden voices which often were not understandable.

Since a free vacation at company expense is generally the result of a paper's acceptance at a computer conference, it has been suggested that for more effective presentations, a practiced speaker be sent to the conference (or recruited from a local office) as well as the paper's author. This added expense for an important paper might indirectly raise the quality of submissions particularly when authors understand that their audiences may be prompted by an audible presentation, to critically question a paper's content.

As another alternative however, the local ACM committee did select an author whom they felt contributed the most effective presentation of a technical paper. The award of a plaque and $200 was given to Robert E. Machol of Purdue University for his paper "There's Still A Place for Interpreters."

While the exhibits were certainly a worthwhile addition to the conference, they consisted largely of cleverly conceived displays, mock-ups and neatly lettered signs. Functioning models of equipment were hardly dominant although closed circuit television for several exhibitors attracted the larger audiences.

Grossly unfavorable in demeanor and value to the exhibit were several booths unrelated to the computing profession and situated in choice locations at which encyclopedias were sold by overzealous pitchmen. One salesman was asked if the Britannica carried a classification for "computing" or "computers" but since a set was not available, there was no reply forthcoming or any real desire to verify the fact. *(Editor's Note: Both the Encyclopedia Britannica and Americana do not carry listings for "computing" or "computers." However, there is a definite heading in the Britannica under "calculators.")*

Throughout the news conferences and in working sessions, industry spokesmen were frank in their criticism of computer technology, perhaps more so than at any other similar conference.

For example: Ascher Opler, Computer Usage, evaluated the state of the art in software development by emphasizing, "We have developed a "tower of babble" in computer languages . . . We have about 100 different languages and we're beginning to develop dialects for each.

"If the programming systems that are in progress now and scheduled for development are completed, it will take about 3,500 man years," Opler added. He concluded that the lack of standardization may be a major obstacle in the growth of computer applications.

M. O. Kappler, president of System Development Corp., and ACM luncheon speaker, told his audience that the computer field is suffering from "too many 'programmers' programmers, and too few programs tailored specifically to do the user's work."

Another prominently outspoken invitee Robert S. Barton, now a consultant and formerly with IBM, Burroughs and Shell Oil, suggested that the so-called computer revolution may be ended unless the industry and scientific leaders address themselves to honest research, not that which is tied to business applications or military crash programs. "The truth is," Barton stated, "there has been no really outstanding contribution to theory since the work of Charles Babbage 100 years ago."

At a panel discussion sponsored by the Joint Users Group (JUG), it was agreed that manufacturers should be required to provide a basic operating system compatible with future systems. It was pointed out that in the case of one manufacturer, 13 installations of a single machine have been made with eight different operating systems currently in use.

In general, this ACM conference has provided the impetus for combining the intellectual pursuits vital to fostering progress in the industry with the financial attractions of bigger and better exhibits and subsequently, directing conference locations at larger population centers to stimulate even higher attendance figures.

While the Eastern and Western Joint Computer Conferences have previously dominated the industry as the principal national gatherings, ACM has made a substantial and successful bid for a third entry in the field. ■

For its fourth successive year, the RAND Symposium was held one day prior to the opening of the Western Joint Computer Conference (May 8th). Participants were placed under no restrictions as to selection of topics, direction of discussion, or amount of time to be spent on each subject.

The Symposium has no legislative effect although votes may be taken during the course of discussion to ascertain the group's feeling or lack of it in a particular area. The RAND Symposium is in effect, a meeting of individuals prominant in the industry who spend a day at RAND in the sharing of ideas.

The all-day session was tape recorded, a 156-page manuscript prepared, expurgated by participants and tightened further (to meet space requirements) by DATAMATION.

Chairman of the session was Robert L. Patrick, a RAND Consultant. Other participants included: Robert Bemer, IBM; Herbert Bright, formerly OEMI and now with Philco; W. Barkley Fritz, Westinghouse; W. M. Carlson, DuPont; J. P. Eckert, RemRand; Douglas Englebart, Stanford Research Institute; Bernard Galler, Univ. of Michigan; Maury Halstead, Naval Electronics Lab; Santo Lanzarotta, IBM; D. D. McCracken, Consultant; Norman Sanders, Boeing; Dura Sweeney, IBM; Herbert M. Teager, M.I.T.; and Frank Wagner, North American. Representatives from The RAND Corp. included Paul Armer, Patrick, Fred Gruenberger, Keith Uncapher, and Richard Van Horn. Opinions expressed reflect the personal opinions of the participants rather than their corporate viewpoints.

This is the second in a three-part series based on the 1961 Symposium.

ALGOL: a critical profile

the RAND Symposium, part two

PATRICK: The future of ALGOL seems to be our first topic. Bemer, would you like to start this discussion?

BEMER: There are people who would like to standardize on an international language, but there is too much confusion around. No reasonable mechanism for maintenance seems to exist. No one seems to be able to answer the basic question, "What is ALGOL?" I foresee a difficult time for ALGOL unless a revised maintenance procedure is devised. The language is too general and has too many ambiguities.

GALLER: I think all of us hoped that ALGOL would become accepted . . . However, it just isn't readable and people don't read it, although I believe that a lot of people could make more sense out of it if they would try. The objectives of the group who put it together seemed to be more toward getting something that could express the most complicated algorithms that they were intending to use, and the poor average mathematician who was not yet even using computers, can only stumble on these things or ignore them completely. Maybe the original objectives should be questioned. I understand that one of the objections to the Princeton implementation of ALGOL has been that it is so general and so slow that no one will even touch it. Their attitude is that it's a good experimental tool, but they can't use it. It seems to me that any implementation, any translator for ALGOL, will of necessity, be this general.

WAGNER: Perhaps what I am about to say was implicit in the two previous statements, but I am addressing myself to the question of what will the future of ALGOL be, and my approach is purely pragmatic. It is my opinion that ALGOL will never be a widely used language by programmers in large computing installations outside of the universities. It has made its run at the leader and failed. I think it can never muster enough strength for a second run, in the terms in which it now exists.

I think, however, that we can logically deduce something else. There are enough things good about ALGOL and it has made a good enough start in more esoteric circles than ordinary day-to-day use, that it will perpetuate itself as a language for expressing algorithms. It will exert an influence within the universities and 10 years from now, when people whom it has influenced in the universities are in a position of command within industry, we may then see a successor to or a derivative of ALGOL in a wide day-to-day use. In the meantime, however, I think the computing industry is being done a tremendous disservice by people who are going around making statements which assume that this is a 100% certainty. I think that this will lead people to make bad decisions which they will regret.

SANDERS: Are we talking about ALGOL as a computer programming language, or as a publication language? As a computer programming language, most of the non-IBM manufacturers are in the process (or say they are) of implementing an ALGOL compiler. If we object that we have a few million dollars invested in FORTRAN programming which we would like to carry over to our next machine, we are told that we will then have a processor created that will convert FORTRAN statements over to ALGOL and that it will be ALGOL from here on in. We are told, therefore, that we should start teaching ALGOL to our programmers. But this will present us with a large problem. We now have many programmers in our shops who have 3 or 4 years of experience in FORTRAN. They are going to object to shifting over to ALGOL, whether or not management desires it, and it would therefore be some time before our programmers became proficient in the new language. It would seem that FORTRAN is now *the* international algebraic language, largely because of the economic motivation, which ALGOL doesn't have. We have to get the work out day after day in non-university establishments like North American and Boeing, etc., and even if we regard ALGOL as a better language, we can't afford to take the risk of implementing it because of these economic considerations.

McCRACKEN: I've been only on the fringes of all this. Would someone outline for me what the objectives of ALGOL were? What was the intent in setting up the language?

LANZAROTTA: Furthermore, COBOL has its CODASYL —what are the motivating forces behind ALGOL?

CARLSON: Speaking also as an outsider, it seems to me

that the objectives of the people who devised ALGOL were the same in their technical framework as were the objectives of the people in the business field who devised COBOL. I can see no difference in the objectives of the two languages, but there is a tremendous difference in the way they went about doing it once these decisions were made.

In the case of COBOL, the people who got together were largely manufacturers and they were essentially committed to speak for their company. There were also users and people who knew something about language structure. In the case of ALGOL, the people who got together were scientists and users, and those who were there in a sense of representing manufacturers were speaking only for themselves. In my opinion, this was the greatest single difference between the two.

ALGOL was set up as a means of communicating ideas in the first instance, and for this you have to have two things, as Norm brought up. First, you have to communicate ideas involving a method from the human being to the machine. This will get something done, but then you also have to communicate from one human to another human so that they can improve on it, build on it, and do something with it. A language must achieve both objectives to become accepted.

BRIGHT: Before we take our gloves off, I wonder if we could get a statement from someone connected with the meeting held in Milwaukee last August (1960) of the ALGOL Maintenance Subcommittee. I believe this is an ACM Subcommittee, presently responsible for the maintenance of ALGOL.

GALLER: I'm somewhat familiar with that. I can't say what has happened since last August, it's my impression that nothing much has happened. We never got active in it.

BRIGHT: Is it safe for us to assume, Bernie, in order to get on with this discussion, that the ALGOL Maintenance Subcommittee has not gotten off the ground?

GALLER: I wouldn't want to say that because I just don't know.

ARMER: Just on past history, I'd say they're probably not doing anything.

WAGNER: I'd like to back off just a little bit and add some discussion to the original question; namely, what the objectives of ALGOL were. In order to do this, it is necessary to remember how it got started. The people in Europe were making tentative stabs at something like this because they all have small machines and they all wanted an algebraic language for them. Some of the people in the U.S. led by John Carr said, "Why don't we do this together and on a grand scale?" The original objective was to create an algebraic language which would be understood and used by and implemented for the users of almost all machines on an international scale. What made this differ from COBOL was primarily that in the case of COBOL, no one seriously differed with the *aims* of the COBOL committee. There was a great deal of objection to the *methods*. There was objection to the executive judgments made in the earlier stages of COBOL as to what was feasible and what wasn't, and what deadlines should be set. But there was no objection per se to the objectives in the case of COBOL.

In the case of ALGOL, there was a great deal of objection to this. There were many people who said, "There is no need for an international standard at this stage of the game. There is, however, on the other hand, a need for ways of permitting many special purpose languages to exist." Among other things, this difference of opinion as to the necessity gave ALGOL one strike before it got started.

GRUENBERGER: It seems to me that Norman's economic considerations should be considered here with reference to the three languages—FORTRAN, ALGOL, and COBOL. FORTRAN fulfilled the classic condition for success: find a need and fill it. Back many years ago somebody saw a need and filled it, however good or bad. In the case of COBOL we shouldn't forget that Charlie Phillips had his very large gauge shotgun pointed at a lot of heads and that provides strong motivation for getting something done.

Now, ALGOL has neither of these motivating features, and what's worse, it is somehow identified with university types and suffers somewhat the stigma of being the first contribution from the universities in about 12 years. It is therefore looked down upon by the day-to-day practical people.

HALSTEAD: A while ago someone said that ALGOL has taken a crack at the leader and failed. Let me ask how long it took the leader itself to get off the ground from the time when it was just a gleam in someone's eye to the point where it was something in daily use. I suspect that the total time has been greater than what we have had so far to implement ALGOL.

And therefore, as a result, it seems to me that we should not expect, with what we have implemented to date, to be good in a practical sense. But the fact remains that we can, today, turn to the ACM *Communications* and read (and of course we can all read) the procedures printed there and understand them. And since we can do that already . . .

GRUENBERGER: I can't.

WAGNER: I have a point of alleged information. Someone stated the other night that 80% of the algorithms that were published in the *Communications* were erroneous because of misunderstanding by the writer.

SANDERS: 80% and more of *programs*, when they are first written, are erroneous too. In the case of these algorithms, there is no good way to test them. You can never tell whether a program really works unless you can put it on a computer, and in this case you can't.

HALSTEAD: I don't think that the future depends upon the fact that it has taken quite a while to get underway. I think we are getting underway, and as a matter of fact, we can put those algorithms from the *Communications* on the computer, and yes, they do work. We haven't tried every one that is printed, so I can't give you a percentage.

PATRICK: Do you have an ALGOL processor working? Is it truly ALGOL or is it one of the various dialects?

HALSTEAD: It's a dialect.

PATRICK: And will it pretty much take the stuff that's printed in the *Communications*? I'm referring to those pages where I read the titles and skip over as fast as possible.

HALSTEAD: Yes, pretty much. We're pretty happy with it. We don't have all the mechanism that's required; for example, we don't have double subscripting, so if an algorithm requires that, we have to change it over to fit our system.

SANDERS: This is getting to the root of the problem. There is only one FORTRAN. (He was interrupted at this point by considerable laughter.) There are dialects, I admit. Again, it's a question of economic motivation. I know there is going to be a January, 1962 version, but the point is that at any one time we are dealing with essentially only one FORTRAN.

TEAGER: It seems to me that before we get down to the question of ALGOL, we're really skirting the question of whether or not we're ready for standards in the field. Whether we like to admit it or not, ALGOL is a sort of an enforced standard which will apply henceforth. When you're looking for something of this type, you're in the same position as the man who is looking for a language which will tie together all science, or as another analogy,

a person who is looking for an Esperanto that will tie together all people with a common communication medium. Now, if you can think of some problem situations which cannot be expressed in ALGOL, graphical problems for example, then it cannot make the claim of being a universal language.

CARLSON . . . Basically, the problem with ALGOL as I see it, is a power problem. There is a distinct source of power which is making COBOL work and there is a diffusion of power as far as getting ALGOL to work. There is no body of people—scientists, engineers, etc.—with common interest in legal problems, medical problems, and other professional interests in any way coming together to say, "We need this." Until you get some organized body of power together, to specify that ALGOL is needed, you're not going to have it.

PATRICK: Herb Bright, do you want to speak for the power?

BRIGHT: I'll try. It seems to me that Walt has expressed well one of the basic weaknesses of the current ALGOL situation. There is no workable mechanism for maintaining the language and for maintaining communication between the people who are building the power. But it's worse than that. What has irritated me since the original publication, and even before, has been that the chief feature, namely its use as a truly common language, has been largely ignored. This is especially true of the university people who have been subjected to all these kicks in the shins (and I feel that they are well called for). I have not yet seen, in casual reading, evidence in favor of any of the dialects of ALGOL which have been created sufficient to warrant their ignoring the virtue of commonness of language.

What has really hurt me most of all is the complete lack of any readable description of the language. People should distinguish carefully between their objections to Peter Naur's write-up and objections to the language itself.

ARMER: I'd like to agree that the lack of a power behind ALGOL is a basic problem, but I think there's another basic problem. It seems to me that an overriding consideration is that for a language to be used on a day-to-day basis by a large number of people in an open shop installation, it must be easily learned and you must be able to retain what you learn. ALGOL just doesn't begin to pass this test. I guess I believe that even if there were a power like CODASYL behind ALGOL, it still wouldn't make the grade.

WAGNER: I'd like to make three short points.

First, in relation to Paul's comment about ease of learning, I'd like to add that such a language should contain a great deal of redundancy. Such a language should be very forgiving, so that when a man makes a simple mistake, the processor can detect it and can essentially process what he did mean. As an example of what I mean, take the English language. If you listen to the tape that is being made right now, you would probably be appalled at the grammar, the syntax, and the apparent confusion in the statements that are uttered—if it were given to a man with nothing else but a knowledge of English and a dictionary. But not one of us will fail to misunderstand what is being said. (General laughter.) Therefore, I say that computer languages of the future must have a high degree of redundancy.

Second, in regard to Herb's comment that the creators of ALGOL were not stubborn enough in trying to keep it truly universal, I think that comment is unfair. When they came up against something that wasn't there, like input/output, or the ability to make tables, or some of the more subtle ambiguities, they had no one to turn to and they had to get their implementation moving along so they had to make a decision. Mr. A made the decision one way, Mr. B made it another; hence, we have dialects.

Third point, and this is purely an administrative point. The word "standards" came up here once or twice. I would like to have us all agree whether, when we speak of standards, we are talking about a registered standard (its sole claim to virtue being that you know what it is) or what one might call a required standard.

Let me explain that latter term a bit. A required standard is one which you do not deviate from deliberately when you don't have to. Take, for example, the American Standard screw threads. Some very powerful organization, like General Motors, could, if they wished, set up their own standards for screw threads and, because of their great economic power, get away with it. But I think the rest of the country would be pretty irritated at such a move, and therefore, we think of it as a required standard. In fact, it's almost a matter of what you might call industrial morality.

So there are really two concepts of standards and we are likely to get into difficulty if we don't keep clear which one we're talking about. In the case of registered standards, there is no implication that you should stick with them or you're a nasty guy. That's one kind of standard. FORTRAN II was such a standard. There were many local FORTRANS, but yet everyone knew what FORTRAN II meant. Whether or not it was a good idea to deviate from the standard FORTRAN II is another question. If you said FORTRAN, everyone understood that you meant FORTRAN II and you could then participate in the advantages of uniformity.

GALLER: I'd like to point out that you don't have to have just one standard. On our master tape right now we have MAD, SAP, and FORTRAN and we don't say which one is standard. One can use whichever one suits his needs.

WAGNER: They're not *required* to use one or the other, but *all three* are standard. When anyone in your installation says SAP, everyone else knows what he means.

GALLER: As one of the co-authors of one of the dialects, I'd like to explain why we did what we did. We started to write ALGOL 58 for the 704, and we quickly found such things as having to make parentheses do the job of other things. So we found along the way various places where we had to depart from ALGOL 58. We found things like the DO and the blank subscript position to be simply unfeasible to put in through a workable translator. Then, too, we found several things that we thought were better than the existing ALGOL, and we put them in. We thought we had found better ways to handle alphabetic constants, switches, and so forth. When we got all done, what we had simply wasn't ALGOL. It was made clear in the original report that if what you put in was not a character for character translation, it was not ALGOL. So we said, "If we can't have ALGOL, let's get the best thing we can." But we did keep as one of our aims at all times the ability to translate easily from ALGOL into our new language. We simply found that we could not implement ALGOL at that time.

WAGNER: At least you had the decency to call it MAD.

PATRICK: Let me make a small transition here. I think we're coming very close to skirting the item on our agenda concerning character sets and standards. I thing this is one of the places where we were very weak in setting up ALGOL originally. Let's face it. There is just one standard in our field called an IBM keypunch, Type 026. It is the means by which we get all but a very piddling amount of our information into our computers, and hence, it is a standard of the field. Bemer had something to say a little while ago about character sets and I personally think that this is the place to start setting standards and not at the COBOL level.

BEMER: Without commenting on that point, Bob, I want

to defend the ease of using ALGOL. You could take a subset of ALGOL and restrict it in such a way that it would be just as easy to use as FORTRAN. It might be a different form, but these are choices that you make. Roy Goldfinger says that you could, if you wish, start from *Alice in Wonderland* and just by making enough changes write a programming language.

PATRICK: That's how FORTRAN got written!

BEMER: Maybe so. You could, if you wish, go the other way. Start with FORTRAN, make a few changes here and incorporate the best features of ALGOL. It doesn't matter. Maybe we won't get it through the ACM Subcommittee on ALGOL; maybe then the FORTRAN standards will absorb all this. Maybe ALGOL is, in many respects, a better language and we should adopt it. Secondly, the standardization that we've been talking about, namely standardization across machines, is a second level of standardization. It's an economic factor, but you don't have to do it. ALGOL has made a set of choices about a basic syntactical structure; it's been shown by Brooker, for example, that you can describe the syntax of a language to a computer and actually make a translator. Brooker has shown that he can take the language he uses and construct a FORTRAN translator in about 8 man-weeks. Presumably he could do the same thing and describe to a computer the syntax and structure of a NELIAC, and let the computer figure out how to construct a NELIAC translator. Through a technique such as this, we can arrange to have anything we wish, like the word "oomph," mean anything we please to a computer and forget about it tomorrow. Why make it a standard of the field?

The third thing that I have down here in my notes concerns the maintenance problem of ALGOL, which is very largely compounded by the fact that you can't describe it in its own language. ALGOL was released before this development could ever occur. This makes it a much less sufficient language; it is not a data processing language; it can't support itself in the field. There is no particular attention paid to I/O, there's no data description, so ALGOL was never really carried to a practical point.

CARLSON: I'd like to stay on ALGOL just a bit more and I'd like to take up Paul's point about training people. If ⅛ of the nit-picking effort that has gone into finding faults with ALGOL were instead put into learning how to use it, this thing could be in operation in a year. I think I have evidence to prove this. One of our engineers decided that people could indeed be trained to use ALGOL and he sat down and wrote an ALGOL primer. Why the people who wrote ALGOL didn't think of writing a primer to explain all this balderdash, I don't know. It didn't take him very long to come up with a full explanation of how you use it. And although it doesn't follow the principles of the teaching machines that seem to be so popular today, it is a step-by-step description and I find that I can read it, Paul. It can also serve as a publication language. We've either managed to live within the restrictions of the 407 and the 026 or we've changed them where necessary. We had to change a few typewriter keys and so on to make it readable. We call this the DuPont Publication Language for ALGOL.

McCRACKEN: Would you tell us why, since you are presumably a user of FORTRAN, you wanted to change?

CARLSON: In part, this was a necessary part of our research in programming techniques. If someone comes up with something new like ALGOL, we must look into it. The fellow who did this work now writes routines in ALGOL and because he can't put them on a machine anywhere, he rewrites them in FORTRAN. He makes the statement over and over that he winds up doing the job in from ⅛ to ¼ the total expended time it would have taken him if he did it in FORTRAN in the first place.

PATRICK: Because he hates FORTRAN and he likes ALGOL.

CARLSON: No, sir. He is an experienced FORTRAN man to start with. He finds that the ALGOL language takes care of many of the things that he has always complained about in FORTRAN, and he adopted and adapted it and he is teaching other people how to do it. My point is that all you need is the will . . . Ours was a small experiment but at least we got some results from it.

McCRACKEN: That's the first encouraging thing I've heard in a long time.

GRUENBERGER: Not only that, but someone has actually done something.

FRITZ: I'd like to make several comments about the future of ALGOL. I think it safe to say that it is not *now* being used. Its immediate future doesn't look too bright. Its long range future may or may not be bright, depending on future motivation. Right at the moment it is evident that industry is not motivated toward the use of ALGOL; it is not being sold. I was on the SHARE ALGOL Committee back in the beginning but I have never been able to sell myself that Westinghouse should go in this direction. Right now we're reasonably happy with old-fashioned FORTRAN II with some modifications that we've added ourselves . . .

McCRACKEN: Something that bothers me is that people in the universities are now using ALGOL and teaching it. What is going to happen when these people who are now being trained get out into industry and find that industry will have nothing to do with ALGOL? What does this say of the long range future for it, and is this a correct assessment of the situation?

FRITZ: Has anyone been approached by an ALGOL graduate looking for a job?

McCRACKEN: Presumably we will be if we're talking about the long range future.

PATRICK: Bernie, has your university produced an ALGOL graduate yet?

GALLER: We are producing hundreds of MAD graduates.

PATRICK: You've been doing this for years!

GALLER: For one thing I find it very enjoyable when former students of mine call me up from industrial installations where they're working and say, "Send me some manuals. I want to show these people what a language is really like." That's one aspect of it. But looking at it another way, for the fellow who knows MAD and wants to go to FORTRAN there is no problem, really. He has to learn only what it is he can't do and what the restrictions are. Basically, one language is really much like another, but I think you'll find that the graduates coming out with a knowledge of ALGOL or MAD or some other language will be better equipped with imagination and knowledge of what computers can do because they've been able to write bigger, better, harder problems. Your only job will be to cut them down and make them satisfied with the tools you give them to work with.

I think there is no danger in having people come out of the universities knowing ALGOL.

I'd like to make one more point. George Forsythe at Stanford is using Burroughs' ALGOL 58 and reports that he is quite satisfied.

PATRICK: There may be a specific reason for this, however. There was no other compiler available for the Burroughs 220 and this one is blinding fast. They would use DUMMKOPF III if it were that fast.

GALLER: For the record, we made a test of MAD on the 704 and it compiled faster than the 220.

PATRICK: I should *hope* it would compile faster on the 704!

GALLER: But FORTRAN did not.

ENGELBART: But how about the running time on the 709?

GALLER: It's about the same.

SANDERS: Although industry apparently hasn't been sold on ALGOL, manufacturers like Burroughs, CDC, Bendix, and so on, are pushing it like mad. It's just that we haven't bought an 1107 or a B-5000 yet. If we did get to this point, we would have to say to them, "either you forget about ALGOL and produce for us a FORTRAN compiler or convince us of the economy of the change." I seriously doubt whether they can do the latter.

GRUENBERGER: I'd like to reinforce one of Maury's points and also put in a plug for Dan. It seems significant to me that with the length of time that FORTRAN has been kicking around (what is it now, some 5 or 6 years?) it will be August of this year before we get a workable textbook in FORTRAN. Dan has written one and it is being published. This will be a real honest-to-gosh textbook (cutting across machine lines) that can be used in the universities to teach something that has been around for perhaps 6 years. If it takes 6 years to get a workable textbook out on ALGOL, the whole machine world will have changed and nothing will work anyway.

CARLSON: Who's going to take the responsibility, Fred, for producing such a textbook?

GRUENBERGER: I don't know. I suppose Dan will turn one out next year.

BRIGHT: Seems to me we have a problem here. If you think back when FORTRAN first burst on the scene, as opposed to a few pioneering efforts like BACAIC, we had very suddenly in our hands a tool which was a giant step ahead of anything else that was generally available at that time. People tend to overlook this fact. It seems to me that there is no arguing the fact that ALGOL is not such a giant step ahead of FORTRAN as a means of expressing things. The question we should face is how should industry go in the future? Should there be an effort to create a publicly accepted standard? Does it make technical and economic sense to go in the direction of something like ALGOL which is strong in the areas where FORTRAN is weak? In effect, what is the proper long range objective? I think it's unfair for people to take the attitude that they have in the past few years that they couldn't be bothered with ALGOL because they had something that would work. This is just a matter of historical habit; people hate to change. We've seen a lot of this in our industry. There are people who couldn't be weaned away from SAP, for example, although I think time has healed this. I think people are ignoring the fact that FORTRAN represented a giant step and ALGOL represents a refinement, a generalization, and a maturing. Without the push that FORTRAN got, it could hardly be expected to have such an effect on the industry.

BEMER: FORTRAN wasn't really such a giant step as far as the language was concerned. This had been done by both Rutishauser and Laning and Zierler at MIT many years before. We also had languages like MATH-MATIC and UNICODE so the differences that FORTRAN represented on the mathematical and algebraic side weren't much. FORTRAN was basically designed as an experiment in object code optimization.

PATRICK: And that's the part that got pulled out.

BEMER: It was a laboratory tool for this, and I suppose because it was produced by IBM it suddenly got large acceptance.

BRIGHT: But it was made available, Bob, and the mere facts of its availability to people in this country and that it was highly efficient in terms of programmer time for problems that were important, had a big effect on the business.

WAGNER: Remember another thing, though. It was backed up by a very large maintenance group. You could count on the fact that in eight years or so all the errors would have been removed. Maury has a wonderful set of languages in his various NELIAC Processors, but I wouldn't use them, even if he rewrote them for the 7090, because I have no assurance that they will be maintained.

SANDERS: It's getting back to the economic consideration again.

HALSTEAD: That particular point of Wagner's sounds good, but I think you're overlooking something else. The NELIAC languages are self-compilers, and anyone who wants to remove what he thinks are some deficiencies can do it himself. He can read the entire compiler the moment he's able to read the language, and the entire compiler doesn't take more than about 50 loosely packed pages. This ability for the user to make his own changes means to me that we don't have to have a large maintenance group. As long as a person leaves the input language alone, he can change anything on the inside that he wishes to. He can improve the efficiency of the compiler at his own discretion and this has been happening all the time.

WAGNER: But that means that my input language will run in my shop one way and in someone else's shop another way. I'm not happy over that situation.

PATRICK: These are unstandard standards.

HALSTEAD: But unless you're on the same machine, it's not going to run the same way anyhow. If you have a method that handles, say, indexing, in a nicer way, you then have an advantage over the other guy. It may run slower on his machine than on your identical machine, but that's all right.

WAGNER: I wasn't interested so much in speed as I was in the similarity of the end products, the output of the object programs.

GALLER: Of course, even FORTRAN has this. If you go from the 704 to the 709 in floating point, you get different answers.

CARLSON: We're still back to the basic problem though, that Maury and Frank are talking about. The question is, "Who is going to use the technology that's behind it, not the program itself?" Maury put this in the framework of just getting the machine to run. That's not the long range problem. The real question is how you pass from one engineer to another what was done or from one doctor to another and so on. This will be the final impact of a language of this sort. The people will understand each other.

SANDERS: The British point of view, if I may represent it, is that this is the only use that a language like ALGOL will have. It will never be any good for placing indiscriminately on any machine.

CARLSON: I thoroughly endorse this.

Subsequent to a discussion on ALGOL at last month's national council meeting of the Association for Computing Machinery, the following motion was approved by the Council:

"1. The ACM supports ALGOL 60 as the preferred publication language for appropriate algorithms.

"2. The ACM continues to encourage research into the development and evaluation of languages for publication and for programming.

"3. The ACM believes that ALGOL 60 is a language worthy of consideration by national and international standardizing bodies."

Following DATAMATION's June issue in which JOVIAL was introduced to our readers, this further report describes the main features of the language and compares them with other procedure-oriented languages — notably ALGOL, of which JOVIAL is a dialect. Though both JOVIAL and ALGOL 60 are derived from ALGOL 58 and consequently share a family resemblance, they have evolved divergently. ALGOL 60 includes conditional expressions, dynamic dimensioning for arrays, and recursive procedures; while JOVIAL includes fixed-point numeric representation, non-numeric values, and input/out and files.

in an ALGOL perspective

A PROGRAMMER'S LOOK AT JOVIAL

by C. J. SHAW, Senior Programming Analyst,
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JOVIAL is a procedure-oriented programming language derived from ALGOL 58 [1] and designed by the System Development Corporation for programming large, computer-based command/control systems. JOVIAL is largely computer-independent; compilers for the IBM 709/7090, the CDC 1604, the PHILCO 2000, the AN/FSQ-7, and the AN/FSQ-31 are currently in operation or in checkout. These compilers fit into a variety of operating schemes that range in complexity from a compiler that operates as one task among many at the call of a complex executive system to one that sits by itself in memory and just compiles programs. This flexibility is due to the fact that JOVIAL compilers are written, in JOVIAL, in a computer-independent and, to a lesser extent, system-independent form.

JOVIAL was built for professional programmers, who hate redundant coding. It therefore uses certain abbreviations: S for Signed; F for Floating; A for fixed; B for Boolean; and so on, which must be explicitly defined away if the expanded versions are to be used. For example:

DEFINE Boolean "B" $

To simplify the discussion, it is assumed that definitions like the above have been given. The JOVIAL abbreviation is the capitalized first letter.

alphabet and vocabulary

JOVIAL's alphabet is the FORTRAN alphabet of 48 signs consisting of 26 letters, 10 numerals, and a dozen miscellaneous marks including the blank, the prime, and the dollar sign. JOVIAL's symbols, which are delimiters, identifiers, and constants as in ALGOL, are formed of compact strings of these signs—compact in the sense of not containing arbitrary numbers of embedded blanks.

DELIMITERS. JOVIAL's delimiters are its verbs and punctuation and are similar to ALGOL delimiters. JOVIAL thus has its quota of separators, brackets, declarators, and arithmetic, relational, logical, and sequential operators —and a set of file operators for describing input/output, a set of functional modifiers for manipulating machine symbols, and a set of descriptors for more elaborate data description, as well.

IDENTIFIERS. Identifiers are labels naming the elements of a JOVIAL program's information environment: statements; switches; procedures; items and arrays of items; tables; and files. Except for context defined statement names, all such labels must be declared, either in the program, or in a COMPOOL or system declaration list. A JOVIAL label consists of an initial letter followed by any string of letters and numerals, which may be punctuated for readability by the ′ separator. Labels must therefore be two or more characters in length. Examples:

U2
STEP1
FLIGHT′POSITION

CONSTANTS. JOVIAL programs manipulate four types of data: numeric data, in either floating or fixed-point representation; literal data, in either computer dependent Hollerith or standard Transmission code representation; status data; and Boolean data. Neither literal nor status values are handled by ALGOL and it is their inclusion in JOVIAL that allows it to describe its own compilation.

Constant numeric values may be denoted in JOVIAL by both decimal and Octal integers and by mixed decimal numbers, which may be suffixed by an Exponential scaling factor or by a (fixed-point) precision indication, giving the number of bits After the binary point. Examples:

```
12
O(34)
.5
6.7E-8A29
```

Literal values, which are, literally, strings of JOVIAL signs, may be denoted in either of the two possible 6-bit-per-sign encodings or directly by octal integers. Examples:

```
27H(THIS IS A LITERAL CONSTANT.)
11T(SO IS THIS.)
O(060706103230)
```

Status values, which are qualitative or categorical in nature rather than numeric, are denoted by mnemonic names. Examples:

```
V(EXCELLENT)
V(READY)
```

And finally, Boolean values are denoted, True by 1 and False by 0.

comments

Comments, in JOVIAL, are bracketed by double prime quotes,
"FOR EXAMPLE, THIS IS A COMMENT."
and may be inserted, between symbols, anywhere in the program. This makes it possible to write JOVIAL in a prose style that resembles fluent, if rather spasmodic, English.

clauses

Strings of JOVIAL symbols separated by arbitrary numbers of blanks, which may be omitted where this does not join a numeral/letter pair, form clauses: item descriptions, which describe values; variables, which designate values; and formulas, which specify values. JOVIAL, however, lacks the conditional expression of ALGOL 60, which effectively selects from a set of variables or formulas that one associated with the first True Boolean formula in a corresponding set of Boolean formulas.

ITEM DESCRIPTIONS. In JOVIAL, the basic units of data are called items. All the necessary characteristics of an item's value, such as its type and the format and coding of the machine-symbol representing it, need be supplied only once, in an item description. Examples:

```
Floating
fixed 10 "bits" Unsigned "integer, ranging from" 1 . . .
  1000
fixed 36 "bits" Signed 15 "fraction bits" Rounded
Hollerith 16 "signs"
Status V(BAD) V(POOR) V(FAIR) V(GOOD)
  V(FINE)
Boolean
```

Literal values may be any length; however, multiple-precision fixed-point arithmetic, though intended, has not yet been implemented by any of the JOVIAL compilers, so that fixed-point numeric values are effectively limited to computer word size.

VARIABLES. Since items are the basic units of data in JOVIAL, they are the principal variables. As in ALGOL, there are no limitations on the complexity of subscripting numeric formulas, which are enclosed in the brackets ($ and $). Examples:

```
ALPHA
BETA($T2$)
GAMMA($0,T2+13,BETA($T2-1$)+1,99*ALPHA$)
```

Although the item is normally the smallest unit of data in JOVIAL, it is occasionally necessary to designate a value represented by part of an item's machine-symbol, which may be considered a string of bits or, in the case of literal items, of 6-bit bytes. This function is performed by the subscripted functional modifiers BIT (operating on any item to designate an unsigned, integral value) and BYTE (operating on a literal item to designate a literal value.) Examples:

```
BIT($FIRST'BIT,LENGTH$)(EMPLOYEE'CODE
  ($EMPLOYEE'NUMBER$))
BYTE($9$)(MESSAGE)
```

FORMULAS. JOVIAL formulas are classified according to the type of value they specify—numeric, literal, status, or Boolean. Though all the operands in a formula must specify the same type of value, an individual operand may be: a constant; a variable; or a function, specifying the value computed by a procedure. Examples:

```
1.0E-4A15
BETA($T2$)
ARCSIN(BETA($T2$),1.0E-4A15
```

NUMERIC FORMULAS. The syntax of numeric formulas in procedure-oriented languages is pretty well standardized. JOVIAL, however, is distinguished by a few minor differences, which bear mentioning: multiplication and exponentiation are signified by * and **, as in FORTRAN; absolute magnitude is signified by the brackets (/ and /); negation may be applied to any operand in a numeric formula, taking precedence over all other operations; fractional or mixed exponents are possible, although any exponentiation yielding a complex root is undefined; there is no integer division operator, as signified by ÷ in ALGOL 60; conversion between fixed and floating-point representation is automatic, where necessary. Other than these, numeric formulas in JOVIAL follow the standard conventions and produce the expected results, although the programmer is occasionally advised to keep an eye on the precision resulting from fixed-point arithmetic. Example:

```
(27*ALPHA($0$)+(/BETA($T2$)/)**-ARCSIN
  (BETA($T2$),1.0E-4A15))/1.889E-6A30
```

LITERAL AND STATUS FORMULAS. Both literal and status formulas specify the value expressed by a single operand. Examples:

```
BYTE($0$)(CARD'IMAGE)
V(COMPULSORY)
STATE(STATE(STATE(V(STATE'001),1H(A)),
  1H(B)),1H(C))
```

BOOLEAN FORMULAS. A Boolean formula specifies True or False, computed from the values of its operands: Boolean constants, variables, and functions; and relational formulas, a further type of Boolean operand containing relational operators. Although relational operators signify primarily numeric relations (EQ, is EQual to; NQ, is uNeQual to; GR, is GReater than; LQ, is Less than or eQual to; LS, is LesS than; GQ, is Greater than or eQual

to) they may also be used to compare literal and status values on the basis of their numeric encoding. Unlike ALGOL, JOVIAL permits multi-relation formulas (for numeric and literal values), which specify True only when all the indicated relations hold. This is convenient for such things as determining whether a value lies within a given range. Examples:

```
INDICATOR
LEGAL (SIGNAL)
WEATHER($AIRBASE$) EQ V(FAIR)
1T(A) LQ BYTE($COLUMN$)(MESSAGE) LQ 1T(Z)
```

The logical operators AND, OR, and NOT may be used to combine Boolean operands into a complex Boolean formula. JOVIAL lacks, however, logical operators for implication and equivalence, as found in ALGOL: Example:

```
INDICATOR AND NOT (WEATHER($AIRBASE$)
  EQ V(FAIR) OR LEGAL (SIGNAL))
```

SENTENCES. Delimiters and clauses combine to form statements, which assert actions to be performed, and declarations, which describe the information environment of the actions. These are the sentences of both JOVIAL and ALGOL. Simple JOVIAL sentences are invariably terminated by the $ separator.

BASIC DECLARATIONS. In JOVIAL, single values (other than those denoted by constants or used only as intermediate results) must be declared as items. The ITEM declaration corresponds to ALGOL's *type* declarations but it may not be used, as they are, to define more than one identifier.

A MODE declaration initiates a normal mode of item description for the implicit declaration of all subsequently referenced and otherwise undefined and unsubscripted items. ALGOL has no counterpart to this declaration, which JOVIAL borrowed from MAD, the University of Michigan Algorithm Decoder.

Rectangular arrays of any dimension may be declared in JOVIAL by listing the size of each dimension after the array item name in an ARRAY declaration. JOVIAL's ARRAY declaration is considerably less sophisticated than its counterpart in ALGOL 60, which allows the programmer to specify a subscript range for each dimension (always 0 thru dimension-size − 1 in JOVIAL) in terms of numeric formulas whose values may vary at run time, thus implying dynamic storage allocation for arrays. Examples:

```
ITEM P66 Floating $
ITEM TALLY fixed 10 Unsigned 1 . . 1000 $
MODE fixed 36 Signed 15 Rounded $
ARRAY CARD 80 Hollerith 1 $
ARRAY TIC'TAC'TOE 3 3 Status V(EMPTY)
  V(NOUGHT) V(CROSS) $
ARRAY LINE 7 5 120 Boolean $
```

NAMED AND COMPOUND STATEMENTS. Any JOVIAL statement—simple, compound, or named—may be given a name, which is separated from the statement that follows by the . separator; and any list of statements, which may be interspersed with declarations, can be grouped into a single, compound statement with the brackets BEGIN and END. JOVIAL lacks the "block" concept of ALGOL 60, where identifiers declared inside a compound statement are undefined outside it and thus may be used for other purposes.

BASIC STATEMENTS. The basic statements of both JOVIAL and ALGOL are similar in effect, but differ slightly in syntax. A JOVIAL assignment statement, however, cannot assign a value to more than one variable, as can an ALGOL 60 assignment statement, and ALGOL lacks the exchange or double assignment statement of JOVIAL, which is signified by the == separator. GOTO statements are the same in both languages, but JOVIAL retains both the IF statement and the IFEITHer − ORIF alternative statement of ALGOL 58, which has since been replaced in ALGOL 60 by the equivalent and more general *if − then − else* conditional statement. Examples:

```
TALLY == COUNT $
IFEITHer TALLY GR 0 $ TALLY = TALLY*2 $
  ORIF TALLY LS 0 $ TALLY = TALLY/2 $
  ORIF 1 $ TALLY = 1 $ END
IF 60 LQ TEMPERATURE($AIRBASE$) LQ 90
AND VISIBILITY($AIRBASE$) GR 3 "miles" $
  WEATHER($AIRBASE$) = V(FAIR) $
GOTO PREDICT $
```

FOR STATEMENTS AND SUBSCRIPTS. A JOVIAL FOR statement activates a subscript (which is an intrinsic, integer-valued variable identified by a single letter), assigns it an initial value, and causes the next (non-FOR) statement listed to be repeatedly executed one or more times. As in ALGOL, a JOVIAL FOR statement includes an initial-value formula, an increment formula, and a limit value formula but lacks the Boolean *while* formula of ALGOL 60 and may not include more than one sequence of formulas. JOVIAL is also limited since its loop parameter is an integer-valued variable that is undefined outside its loop, while an ALGOL loop parameter may be any arithmetic variable. JOVIAL has the advantage, however, of allowing the omission of the limit value formula in a FOR statement, thus creating a loop without an implicit termination test, and also of allowing any number of these shortened FOR statements after a complete FOR statement, creating a multi-parameter loop, with one controlling parameter and many non-controlling parameters, all of which are incremented each repetition. Example:

```
ARRAY       NODE 25 25 Floating Rounded $
      TRANSPOSE. BEGIN
                 FOR I = 0,1,24 $
                     BEGIN
                     FOR I = 0,1,24 $
                         NODE($I,J$) ==
                         NODE($J,I$) $
                 END END
```

TABLE DECLARATIONS. A table is a matrix of item values whose columns are linear arrays and whose rows, called entries, are therefore related sets of different items. Typically, entry K (NAME1(K), - - -, NAMEn(K)) would designate values measuring the n pertinent attributes of "object" K. A table's entries all have the same composition since each consists of a similarly named and ordered set of items declared within the BEGIN and END brackets after the TABLE declaration.

```
TABLE PAY'ROLL  Variable "length" 1000 "entries
  maximum" Dense "packing" $
                BEGIN
ITEM EMP'NAME   Hollerith 18 $
ITEM EMP'CODE   fixed 12 Unsigned $
ITEM PAY'RATE   fixed 10 Unsigned $
ITEM YTD'EARN   fixed 24 Unsigned $
                END
```

The JOVIAL programmer also has the ability to declare: tables with entry structures like those of previously declared tables; tables with entries for which storage allocation is completely specified; and tables with entries

composed of variable length item-strings, rather than single items.

Tables are the important data structures in most JOVIAL programs, so the language provides three functional modifiers to aid their manipulation: NENT (for Number of ENTries), which allows this unsigned, integral value to be designated for Variable length tables and specified for Rigid length tables; ALL, which creates a loop to cycle through an entire table when used in an abbreviated FOR statement; and ENTRY, which allows an entry to be considered a single value, represented by a single, composite symbol.

Example:

```
FOR I = ALL(PAY'ROLL) $
"Eliminate empty entries."
      BEGIN  SEEK'EMPTY.
      IF ENTRY (PAY'ROLL)($I$)) EQ 0 $
            BEGIN
            NENT(PAY'ROLL) = NENT(PAY'
ROLL) - 1 $
    IF ENTRY (PAY'ROLL)($I$)) EQ 0 $
                BEGIN
                ENTRY (PAY'ROLL($NENT
(PAY'ROLL)$))
== ENTRY(PAY'ROLL($I$)) $  GOTO
SEEK'EMPTY $
      END  END  END
```

MISCELLANEOUS DECLARATIONS AND STATEMENTS. The JOVIAL OVERLAY declaration names sets of items, arrays, and tables that must share a common memory block. Each such set thus "overlays" the other sets listed in the declaration. In contrast, ALGOL 60's *own* declaration lists those environment elements that must not be overlayed.

In JOVIAL, though not in ALGOL, it is possible to declare items with specific initial values. For simple items, this may be done by inserting, into the item declaration, the descriptor Preset followed by the desired constant. Array and table items, however, are initialized by arrays of constants, listed immediately after the declaration.

The JOVIAL DEFINE declaration establishes an equivalence between a label and an arbitrary string of signs by effectively causing the sign string to be substituted for the label wherever it may subsequently occur. This allows the programmer to abbreviate lengthy expressions, to make simple additions to the language, and to create symbolic parameters – functions no "higher-level" programming language should lack, though most of them do.

The JOVIAL CLOSE statement is a closed and parameterless subroutine removed from the normal sequence of statement executions and invoked only by a GOTO statement (which may be a switch call). Its normal successor is the statement listed after the invoking GOTO statement.

A DIRECT statement allows the inclusion of a routine coded in a machine-oriented programming language. This routine, enclosed in the brackets DIRECT and JOVIAL, may set and use JOVIAL items.

JOVIAL also includes: a TEST statement, which terminates the iteration of a loop; a RETURN statement, which terminates the execution of a procedure or a closed statement; and a STOP statement, which terminates the execution of a program. The TEST and RETURN functions are performed in ALGOL 60 by *go to* statements.

switches

Two kinds of switches may be declared in JOVIAL: indexed switches, which are similar to those in ALGOL; and item switches, which have no direct ALGOL counterpart. The numeric formula subscripting the name of an indexed switch indexes the list of statements or switch calls given in the SWITCH declaration, while the numeric formulas that may subscript the name of an item switch index the item name given in the SWITCH declaration and thus designate an item value that is compared for equality with a list of constants, also given in the declaration, to select one from a corresponding list of statement names or switch calls. In either case, the failure of a switch to compute a statement name effectively specifies the name of the statement after the GOTO statement invoking the switch. Examples:

```
GOTO STEP($K-1$)
SWITCH STEP = (STEP1,STEP2,STEP3, , STEP5,
  STEP6) $
SWITCH BRAND (WEATHER)=(V(STORMY)=
  MAINTAIN 'SUMMARIES, V(CLOUDY) = STEP
  ($STATION-1$),V(SUNNY)=STEP4) $
```

procedures

A procedure, which is a self-contained computation with a fixed and ordered set of formal parameters, is invoked by a procedure statement or a function call. Calling parameters in JOVIAL are either: values, as specified by input formulas and as designated by output variables; or arrays, tables, or statements, as indicated by name. Formal parameters corresponding to calling parameter values must be declared as items within the procedure, and those corresponding to arrays and tables must be declared as such to provide the procedure with a fixed definition of their structure. The procedure itself is executed as though its formal parameters either designated calling parameter values, or were replaced with calling parameter names.

JOVIAL uses the ALGOL 58 convention of separating input parameters from output parameters by the = separator. As in ALGOL, identifiers declared inside a JOVIAL procedure are defined for the procedure only; and for a JOVIAL procedure to specify a function value, its name, considered as the sole formal output parameter, must be declared as an item within the procedure. Although JOVIAL procedures may invoke other procedures, they may not, either directly or indirectly, invoke themselves – as is possible with ALGOL 60 procedures. Furthermore, they lack ALGOL's complete call-by-name facility, since a parameter that is a name provides a JOVIAL procedure only with a memory address, and not a structure. Example:

```
PROCedure WORDSORT (WORD,LENGTH=
  ERROR) $
"A procedure that sorts a given length list of 5-
character words into alphabetic order."
ARRAY  WORD 0 Hollerith 5 $
ITEM LENGTH fixed 15 Unsigned $
ITEM   ERROR Boolean $
               BEGIN
               ERROR = LENGTH LS 2 $
               IF ERROR $  RETURN $
          FOR I = 0,1, LENGTH-2 $
                    BEGIN
                    IF WORD($I$) GR WORD
($I+1$) $                BEGIN
                         WORD($I$) ==
WORD($I+1$) $            FOR J = I,-1 $
                              BEGIN
          IF J EQ 0 OR
WORD($J$) GQ WORD ($J-1$) $       TEST I $
                                  WORD($J$) = =
```

```
WORD($J–1$) $
                END  END  END  END
```

input/output and files

To allow reasonably efficient and computer-independent description of input/output processes in JOVIAL, all data entering or leaving the computer's internal memory is organized into files. A JOVIAL file is a string of records, which are themselves strings – of bits or of 6-bit Hollerith coded bytes. In general, records are composite symbols, which may represent entire groups of values when stored within the computer's internal memory.

A file is activated by the execution of an OPEN INPUT or OPEN OUTPUT statement, and deactivated by a SHUT INPUT or SHUT OUTPUT statement. Active files may be both written and read, one record per transfer, although somes files are read-only or write-only depending on the external storage device involved. An INPUT statement initiates a read operation, which transfers a record from the file into memory so as to represent a designated value or group of values, and an OUTPUT statement initiates a write operation, which transfers the record representing a specified value or group of values from memory out to the file. The index of the record currently available for transfer to or from the file is designated with the file-position functional modifier POSition, and ranges from 0 (indicating "rewound") thru number-of-records (indicating "end-of-file"). The transfer of a record to or from a file automatically increments file position by one and, where the storage device allows, file position is a variable that may be altered by the assignment of an arbitrary value. The file is then called an "addressable" file, as opposed to a "serial" file where such a general positioning operation is to be avoided as impossible or inefficient.

Files are declared either binary or Hollerith in type, and associated with each file is a set of status constants denoting the possible states of the storage device containing the file. File status may thus be determined with a relational Boolean formula wherein the file name is considered as a status variable that is automatically updated prior to comparison according to the current state of the file's storage device. Example:

```
SORT'LEXICON'LISTS. "A routine to sort the word
lists in a lexicon, using the WORDSORT procedure
above."          BEGIN
FILE LEXICON Hollerith 1000" records
maximum"Rigid"record length of"
500"bytes"V(INACTIVE) V(READY)
V(BUSY) V(ERROR) DRUM'2000 $
ARRAY   LIST 100 Hollerith 5 $
ITEM TROUBLE Boolean $
                OPEN INPUT LEXICON $
READ.           INPUT LEXICON LIST $
READY.          IF LEXICON EQ V(READY) $
                    BEGIN
                    POSition (LEXICON) =
POSition (LEXICON) – 1 $
                   WORDSORT (LIST,100 =
TROUBLE) $          OUTPUT LEXICON LIST $
                    GOTO READ $
                    END
                IF LEXICON EQ V(BUSY) $
                    GOTO READY $
                IF TROUBLE OR LEXICON EQ
V(ERROR) $          GOTO CORRECTION $
                SHUT OUTPUT LEXICON $
                END
```

JOVIAL lacks a FORMAT declaration (as found in FORTRAN, for example) and with it the ability of most business compilers to automatically insert, in programs, input editing and report writing routines. Although this lack is JOVIAL's main weakness as a practical programming language, it can be partly remedied with library procedures.

programs

A JOVIAL program is a list of declarations and statements enclosed in the brackets START and TERM and followed by the $ separator, which indicates the typographic end of the program. The name of the first statement to be executed may be inserted after the TERM; otherwise it is the first statement listed that is not part of a procedure.

evaluation

Both JOVIAL and ALGOL, it seems, were designed by committees, but JOVIAL's poly-parentage is the more painfully apparent; it is not as "pretty" a language as ALGOL. For all its minor notational flaws, however, JOVIAL is a much more useful programming tool. It includes as much of ALGOL's capabilities as do most ALGOL compilers (which tend to omit the hard parts) and further capabilities as well, permitting JOVIAL compilers to be written in JOVIAL. In addition, though JOVIAL can be quite cryptic in the hands of programmers uninterested in readability, it is very easy to write JOVIAL programs that can be read by non-programmers. In this respect, though no claim is made that JOVIAL programs can be written by non-programmers, JOVIAL compares favorably with COBOL. In short then, JOVIAL is probably as powerful a tool for systems programming as exists today. ■

CIRCLE 119 ON READER CARD

C. J. SHAW

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an editorial commentary

COMPUTER PEOPLE AND THEIR CULTURE

by Dr. H. R. J. GROSCH, Contributing Editor

There's a boom on in morality: it's "in" to be ethical. We're bullish on beatitude, bearish on boorishness. Ah me, how refreshing! So I propose in this article to venture into the territory of a fellow sachem. In deference to the tender feelings of Thompson Publications I shall refer to him only briefly and by his Spoonernym, Irk Badly. Irk and his ilk, if I may be permitted the phrase, have called for organized action by ACM or AFIPS in the social, the moral arena. They wanted to do this long before ethics became an OK word – long before the foundations began paying off on moral philosophy. We owe IB&HI a vote of thanks, and I tender one herewith: prophets, a smidgen of honor!

In my view, there are three regions of social responsibility. In the first, the deepest personal and individual moral values are in question, and our professional societies should not normally be involved. In the second, we deal with internal questions, questions which concern us as a guild. And in the third, we face problems of concern to society as a whole which arise in our discipline, or where our special knowledge is needed for the guidance of policy makers outside our specialty. As examples of problems in the first region, consider these: should one design or direct weapons of mass destruction or unusual beastliness; should one participate in medical research which in saving individual lives permits the passing on of dysgenic factors; should one teach in a segregated school; should one work in an industry that wastes or pollutes natural resources, or debases public taste? As examples in the second region: should we establish standards for CPP's (certified public programmers); should our society journals refuse misleading advertising; should BEMI be allowed in AFIPS? As examples in the third: should computers push the button in missile warfare; should we use computer-centralized teaching machines in our schools; should we encourage national information systems with comprehensive dossiers; should we cybernate American offices and factories at the maximum possible rate; will computing machines think?

individual responsibilities

As individuals, we should be searching for our own answers to problems of the first kind. Indeed, I don't believe a man or woman should presume to put finger to button in our business without being frequently and deeply troubled by such questions. The power and universality of our tool, for good or ill, is too great to be entrusted to moral idiots. But we should be concerned as intellectuals, as voters, as citizens of the free world – not as members of the ACM. There are other organizations where unified action is appropriate: the Federation of American Scientists; political parties and action groups; local associations. Of course, those of us who are senior in the AFIPS outfits have a lot more leverage than we would have as, say, freshman members of ADA; it's a temptation to want to use that leverage, a temptation we must resist.

guild action

Certainly everyone agrees that professional standards, salary surveys, university course accreditations are proper matters for our organizations to discuss, and that "some day" such problems should be tackled. It is a curious circumstance that the groups which have already shown some concern for professional standards, member education, and employer relations are the very ones the charter members of AFIPS are too pure to embrace – NMAA, for instance, which has a very real although perhaps rather wide-eyed interest in such matters. I often wonder if the term "Founder Society" may not have prophetic significance!

Our hardware adherents can look to the more antique parts of their parent organizations, and to the licensing provisions for professional engineers. But while these cover things like safety in electrical machinery, or consulting ethics, many of the problems brought by the ever-accelerating dynamism of modern electronics are not included. On the software side we have no ancient history

of boiler safety codes or union busting to guide us. I believe we should organize preliminary study groups in AFIPS and get to work. The recent surge of interest in language standards, printer alphabets, and so on is healthy, but it would have been better if these could have followed guild action on how to interact with manufacturer organizations, how to work in user groups – in a word, if we had discussed the human problems first, before frolicking off after the Pied Piper of progressive programming. To be specific, I recommend a committee on professional matters, with subcommittees on professional standards, professional development, college accreditation, relations with manufacturers. There might well be *ad hoc* subcommittees reporting on the advisability of a CPP licensing authority and on policing of advertising (at our meetings, in our own journals, and in general publications).

I'm quite serious about both the latter items. It's discouraging enough to read the gaudier garbles in the public and trade press, without encountering it in the ones we control. And recruiting practices, on paper and at meetings, need attention; the old JCC meetings committees were always in Dutch. And about the "public" programmer, by analogy with the public accountant – well, my idea is this: most future auditing and examination of records will require access to cores, disks, drums, tape, and their putative successors. We can wait for CPA types to find out the tricks of our trade, establish licensing provisions, train a substantial number of their younger subalterns in machines and programming languages, and take over the task. Or we can establish a parallel license, team up with the CPA's for accounting and auditing tasks, and work in other directions independently. For instance, who will hire out to the congressional committees investigating systems failures in air traffic control, real-time Internal Revenue swindles, or tampering with the weather? The hardware merchants will claim there was a bug left in the programming system, the contractors who wrote same will say it was the operational program, and the programmers will – as always – accuse the machine. An independent CPP would exactly fit the bill. And I can't really feel a mechanized CPA would trap many defalcators in the world of tomorrow, even on home grounds. There are too many technical angles, too many ways an embezzler can creep into the bits and out with the bucks. Full time interest is needed.

on the firing line

The first two regions of morality were reasonably easy to handle; I could recommend individual attention in the first, and guild action in the second. But the third area, where our computer-oriented abilities impinge directly on the social structure – that's the tough one. I'm going to use one major example to make my case, and leave it as an exercise for you readers to decide whether to extend the argument to artificial intelligence, teaching machines, cybernated military decision-making, and the like. And so that the example can be read meaningfully, I'll summarize my position first: we should work through our technical organizations to put together facts and substantive predictions; the organizations should volunteer these to official agencies, and to the press and other media, not waiting to be asked; *as individuals* the members of our organizations should feel free to volunteer recommendations; the organizations, however, should *not* make recommendations on behalf of their collective membership except in the unlikely case of clear, urgent national peril. I'll say it again: our organizations should offer facts, their members should offer solutions.

Consider the problem of technological disemployment (that is, unemployment due to the elimination of an entire job category); on the farm, in the factory, in the office, machines are taking over from people. Computers will get a large share of the blame – unfairly, in almost all of the early cases. Our pets have had little to do with improvements in mining machinery, faster packaging equipment, materials handling advances. But increasingly they will be involved, and in any case computers *personify* cybernation. Transfer machines are so impersonal, conveyor belts so featureless – but a computer console, especially a poorly thought-out one with *lots* of signal lights in several colors, banks of switches and knobs, a couple of trouble-shooting 'scopes – there, fellow citizens and union members, there is the enemy!

All the decision makers, all the decision influencers, all the decision critics are watching. We can expect questions from every side; in fact, they started some time ago: what's behind all this, how did we get here, what happens next, how far will it go? Are people obsolete? Can we retrain assembly line workers? How about the service industries? What does this augur for education? Who will consume what your machines produce? Now, some of these questions can be answered with facts and "solid" prophecy. We can tell about antediluvian times, Babbage and Aiken, and we'd better be ready with Eli Whitney and Oliver Evans as well. We can recite about relays and vacuum tubes and transistors, and boast of the thin films and cold magic to come. We can explain how we tell our charges what to do, and how to educate others to do so. We have, or can assemble, figures on how our field has grown, lists of areas where it has been introduced and places where unusually significant examples are available. We can see how digital controls open up small-lot machine shops, and what it would take to cybernate passenger car and truck travel on a 1970 freeway. Best of all, we have facts and predictions on the myriad interconnections with other aspects of tomorrow's technology; few disciplines sample so many sciences, so many businesses; information processing is the unexcelled path to information!

But those other questions—not "what comes next?" but "how far shall we go?"; not "how much do console operators earn?" but "what will we do with the bookkeepers?"; not "how clever are your machines?" but "do they know too much?"—those require study, discussion, perhaps a little evangelism. I believe we should set up, not only in the AFIPS organizations and proximate outfits like NMAA, but also in instrumentation and control societies, the older engineering societies, and other interested and affected parties, special discussion groups to sponsor sessions at regular meetings, hold separate meetings of their own, get together with similar groups in other organizations, and in general exercise the minds and tongues of their members. The object is to prepare those members, and to a lesser extent all members of the parent organization or organizations, to comment on the tough questions, the involved questions. The object is to make it possible for individuals to recommend solutions, to recommend milestones, to recommend goals. Our professional organizations should not do this; I do not believe they can afford to do it even if they would. As individuals, though, we can and should be heard, and our organizations can help us think through what we need to say. ■

A NEW WORD

We badly need a word for "automation, data processing, computing, and computer control." I have introduced here the term "cybernation," coined by Dr. Donald N. Michael, of the Peace Research Institute. How does it strike you?
HRJG

With recent advances in monitoring, multi-programming and teleprocessing, computer consultant Adams voices one approach to the open vs. closed shop quandary. Unstated but implicit in Adams' hypothesis is that while implementation of his proposal may be distant, feasibility is certainly plausible, and although the name he has coined smacks lightly of cheese, Adams' analogy lies elsewhere.

COTTAGE COMPUTING

a swinging door for the closed shop

by CHARLES W. ADAMS, Adams Associates Bedford, Mass.

Prepare programs in an open shop or a closed shop? Debug the programs at the console or away from it? How many happy hours have been spent debating these fascinating questions! The correct answers, as everyone who thinks deeply about the problem will no doubt agree, are closed and away. But, lo, a new approach must now be considered, made possible by the recent advances in multi-programming and teleprocessing. The new approach? Cottage computing.

The desire to save computer time and programming time is presumably uppermost in the minds of those who manage their centers on the open shop plan, in which the users write their own programs. The same advantages are claimed for the closed shop, in which properly-caged programmers protect the computer from its ultimate users. Two months ago, a bearded friend of mine, writing on these same pages, sagely remarked that management people sometimes "assume that programming costs are minimized by an open shop, where instead they are increased, but hidden."

Ever since the first high-speed computers went into operation, most computer managers, whether advocating open or closed shops, have waged war against those who debugged their programs at the computer console. As rental costs have risen, the urge to keep the man away from the machine has gotten ever stronger. It is contended that both programming time and machine time can be saved through use of appropriate debugging aids divorced from the computer console. Sometimes hard-and-fast rules are established, intended to be broken only by the manager himself.

Simple post-mortem printouts often provide the clues necessary to locate a programming difficulty. In the worst cases, interpretive tracing provides an almost infallible, though certainly time consuming, means of detection. Refinements of these techniques have been legion, giving the programmer a wide choice of snapshot tracers, changed-word post-mortems, and more esoteric schemes he cannot hope to understand. Working up the refinements has also provided the utility system programmers opportunity for countless hours of fascinating entertainment, busily console-debugging their own off-console debugging aids.

Now, in 1961, comes cottage computing, a technique fostered (under different names, of course) at M.I.T., Carnegie Tech and elsewhere. The name stems from the observation that the new kind of computer users, working at their own pace and at their own location with their own equipment, will resemble the textile workers of the 17th century whose piece work was carried out at home and came to be known as the cottage industry.

In cottage computing, the scientist, engineer, or manager has access to a high-speed digital computer through some sort of simple but versatile console located in or near his own office and constantly at his disposal. Through it, he and the computer are in close communication, an intimate association in which the user is not only able to see results without delay as they are generated, but is frequently prompted by the computer in actually defining his problem.

While the user receives the impression of being in full command, the computer retains control of the entire operation, performing the work requested by the users on a schedule adjusted from moment to moment in accordance with the demands of the several users. Efficient use of the machine is readily obtained through multi-programming, the computer being assigned a number of consoles to service plus a backlog production job to carry on in its spare time. Computation and/or printing of any volume are of course carried out at the computer center proper—it being primarily for experimental and developmental purposes that cottage computing is most useful.

The significance of this new approach to computer utilization is two-fold. First, it will make digital computers increasingly useful in fields of endeavor where experiment, imagination, and judgment play a leading role. Most of the improvements and many of the breakthroughs in man's understanding and control of his environment have been achieved by the simple process of cut-and-try. Cottage computing will aid managers, designers and researchers in applying cut-and-try procedures to new and vexing problems involving complex or voluminous arithmetic, logic, or file reference. No longer must the computer user anticipate and provide for every contingency in advance.

The second and perhaps more important implication of cottage computing is the joy it promises the confirmed compiler and utility-system programmer—the imaginative chaps now making half-hearted changes in FORTRAN while waiting for the dust of COBOL and ALGOL to settle. Not only will new input-output schemes be required to permit man and machine to communicate effectively, but elaborate information-retrieval, time-sharing and other special techniques can be developed as well. The sophisticated cottage executive routine will no doubt learn the quirks and foibles of its subscribers, either improving its own responses or rapping the user's knuckles as circumstances dictate. What greener pastures could we programmers seek? ■

Each model of the B 200 series utilizes a similar basic central processor, modified according to the system to facilitate various configurations of I/O devices.

Specifications include: 4,800 character positions, alphanumeric core storage, each position individually addressable. Each position contains seven bits (P, B, A, 8, 4, 2 and 1). Odd-bit parity checking is included.

Instruction fields are 12 characters in length, 2-address, 28 instructions. There is a maximum of approximately 24 instructions for one system at any time.

Data fields are variable. As many as 120 positions may be transferred with one instruction. Arithmetic operand fields can be up to 12 characters in length.

Comparison indicators facilitate testing for a high (plus or greater than zero) equal (or zero) or low (minus or less than zero) condition which resulted from the execution of an arithmetic or compare instruction. Average instruction time is approximately .9 milleseconds. Commands are executed in sequence, unless a branch is initiated. Central processor controls all input/output and contains two input buffers for card readers and/or sorter-reader) and one output buffer (for punch unit).

BURROUGHS ENTERS "CARD WALLOPER" COMPETITION

a design study of the B 260

The Burroughs B 200 series formally announced in New York City last month consists of four models: two for the banking market, the B 250 (Visual Record Computer) and the B 270 (sorter lister), and the two most recent additions, the B 260, the card processor, and the B 280, the tape processor.

The B 260 was born to solve the usual dilemma of the punched-card user—how to expand his shop without submerging himself in machine duplication. Most of the investment in a tabulating shop is contained in the 407—521 subsystems. These subsystems are capable of performing a variety of printing and summarizing tasks. Together with a 604 calculator, they can handle normal applications supplemented by an array of satellite equipment.

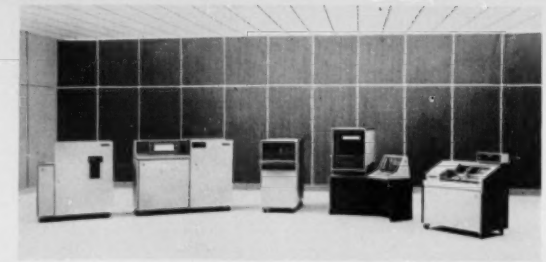
The problem is to achieve an increase in performance by multiplying the speed of printing, calculating, and summary punching to develop a product which a card man usually visualizes as a "card walloper." Therefore, the B 260 was organized to replace tabulating equipment with no particular application solution in mind. The Burroughs objective for this system was direct penetration into the current IBM stronghold, specifically the lucrative 1401 market.

In attacking this problem, Burroughs was faced with the following constraints—if they operated at too high a performance level (because performance is normally associated in some manner with cost), they would price themselves out of the volume market. If they offered too low a performance level, they would probably generate only a large 407 complex with little to recommend the final product. The target objective therefore chosen was that the system would cost between $2,000 and $5,000/month in rental with a performance level of approximately four to five 407-521 combinations. The unit would also be able to calculate and therefore replace the satellite 604.

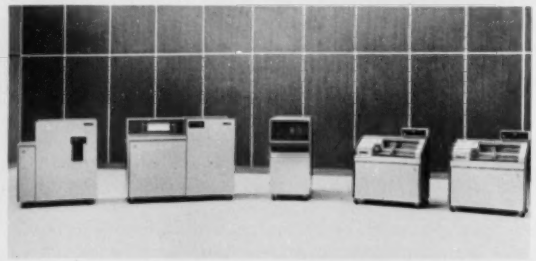
As a first pass, this would provide a print speed of between 600 and 700 lines/minute, a summary speed of 200 to 400 cards/minute, and a card reader capable of supplying information at the desired output rates. Since it was Burroughs' intention to keep their peripheral gear running at maximum speed at all times, it was decided to design a completely buffered control system. One of the tasks that always confronts a tabulating operator before his 407 run is some necessary degree of collation between master and detail files. This further added the design criteria that two readers would be quite an asset to the system. The basic configuration is therefore two input readers, an output punch, and an output printer, all of which are completely buffered, and a central control box handling normal arithmetic, logical, and data editing functions.

The present organization of the B 260 is one or two input card readers of 800 cards/minute, one output punch of 300 cards/minute, and a wide-line printer operating at approximately 700 lines/minute. Both the readers and the printer are completely asynchronous in operation. The punch is synchronous and will slow down to 263 cards/minute if its normal cycle is exceeded. The

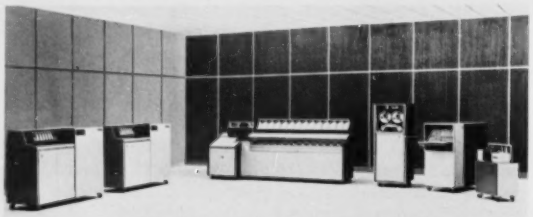
BURROUGHS B 200 SERIES



B 250 combines the advantages of high speed punched card dp with traditional ledger cards. A typical system consists of a central processor, record processor, card reader, card punch, and printer.



B 260 system in a maximum configuration consists of a central processor, two card readers, card punch and printer. The system will lease for $3,750 monthly, and sells for $182,650.



B 270 reads and sorts MICR encoded documents, and records data on magnetic tape. In addition to a sorter-reader, a typical configuration includes a card reader, central processor, two six-tape listers, and magnetic tape unit.

B 280 adds magnetic tape units to the B 260 and can be used as an off-line system performing peripheral operations for the B 5000 or other large and medium scale computers. Maximum system includes a central processor, two card readers, card punch, printer, and six magnetic tape units.

speed of the computer is such that it is capable of keeping the peripheral gear of the system operating at its maximum rate.

The problem of design (controlling these four pieces of peripheral gear and computing simultaneously) was one of minimization. Everything must balance. Operation is with a punched card containing 80 characters, and printing to an output line of 120 characters. It was decided that information coming in would be in serial form. Buffering would be on an interrupt basis between card columns. The drum printer is sampling data at much too high a rate for interrupt-type control. Therefore, a full buffer must be included in this unit. The punch uses a single row buffer. It is a parallel punch and functions on an interrupt at the end of each command. There are exceptions, of course, in the long multiply, divide, and transfer commands. At each interrupt, 80 characters will be transmitted from memory to the row buffer for punching, and commands will resume at the end of this transfer. The computer itself is a three-address system. It has 14 commands: add, subtract, multiply, divide, compare, branch, transfer, mask, halt, no op, read, punch, print, and print skip.

These instructions occupy twelve characters of memory. Nine of these characters are taken for the three addresses necessary for the instruction, a single character is taken for the master op code, and two are field length designators. This is a variable field length machine with the length of field varying between one and twelve characters. Though it is a three-address machine, only one address register is used for addressing memory. Here, Burroughs took the position that if selling prices could be reduced, they would sacrifice compute speed in all cases.

The system does arithmetic as one would perform it manually. First, an address is picked up, then a corresponding digit or character of information. In an add command, when two fields are to be added and stored in the third field, the order is as follows: First, the A address is picked up; then the A digit of information, followed by the B address and its B digit. The C address is picked up, A and B added together, and the information stored. Now, the readers and punch are sampled. If information is to be transferred in or out, the user stops the command, transfers this information from the appropriate area to the appropriate unit, and then returns to the unfinished command, picks up the A address, and starts again with modified field lengths.

Because of this organization, it is necessary to have three unique areas of memory. These are designated unaddressable buffer areas, though from an electronic point of view, they are merely memory extensions. These memory areas contain 80 columns of card information and the address of the buffer location being referred to during an input or output. This buffer address is picked up and used to store information in the buffer sections. As far as the total memory organization is concerned, it contains 5160 characters of memory, 4800 of which are addressable and 360 assigned as memory buffers. This memory is organized into a 60 x 86 bit area. The memory is 7 planes high; 6 for character representation bits and 1 for a parity bit. This provides up to 400 12-character instructions available to the programmer.

The rental of the B 260 is approximately $3,750/month. The design objective has been met. Because of its complete buffering, it is able to operate at approximately five times the speed of a 407-521 combination. With its built-in calculating ability, it can also take all the work load of auxiliary 604 units, and can assume, with its dual reader input, some of the work performed by a collator. ■

CIRCLE 117 ON READER CARD

YOU NOTICE HOW NO ONE

by JACKSON W. GRANHOLM
Thousand Oaks, California

Jasper[1], among others, has, for a number of recent years, kept careful track of the sundry nuances and minor fluctuations in meaning of key words in the English language. With his colleagues and associates Jasper contributes regularly to those lists and compilations of current usage that are vogue among the languagemen. Should a new word be used in English at, say, a Democratic political ralley in Boise or a Literary Tea in Savannah, Jasper and his friends are immediately aware. So excellent is the scholarly spy system of these pedagogues that no verbal or conjunctive creeping slyly into the vernacular goes unnoticed.

It is, then, to such men as Jasper that we are indebted for the precise knowledge of the cancerous and monstrous growth of quasi-verbalism proliferating about the digital computer. To one like yr. obt. author, exposed daily to the press releases and related hoopla of the reverend hardwaremen, the facts are all too clear – the portent, most forboding!

It has been over a year since Jasper pointed out that there are, apparently, in the United States of America, no people who *USE* digital computers. There are, if we believe the current literature, many who "utilize data processing systems."

This meshes with Nattkarl's description of "system" as an "OK word that refuses to die." It may, in fact, be fairly said that the majority of the big computer makers are thoroughly enmeshed in the "system" system, so much so in fact that a recent press release describing a new electronic method of extending bad credit a few months referred to it as "the single-card system."

System is readily seen to invade all levels of abstraction and concretion, singular and plural, past and present. Hence we give hardly another thought to reading about the tape system of the input/output system available with the latest data processing system.

It would thus appear to the thinking man (everybody who agrees with the author) that we may as well resign ourselves to "utilizing systems" and we might as well forget about using machines.

Another new by-word of computer-oriented talk is "instantaneous." According to Schaufel, "instantaneous" or its derivative, "practically instantaneously" appear, on the average, 2.67 times per paragraph in the typical press release of the typical computer maker. This is so in spite of the fact that McGee, as long ago as 1954, carefully pointed out, "The number of microseconds in an hour is a constant."

The pseudo-adjective "solid-state" runs rampant through circuitry verbiage these days. Frequently it is accompanied by its attendant phrase, "virtually no moving parts." It is interesting to note that, when a group of 73 electronics hardware public relations men was asked to define "solid state," only one man could do so. His definition was manifestly erroneous.

The foregoing provides but one, possibly poor, illustration of St. George's[2] dictum that "The less one has to say, the more elegantly he is apt to say it."

The tendency to speak in automobilesalese is not, unfortunately, limited to the press release pundits. One is quite apt to overhear the chief design engineer on the FRED (fiendishly rapid electronic device) project refer to "breakthrough in the state-of-the-art" or "in-house technical ability." The theme songs which characterize the meetings of the most hard-nosed and factual of computer people have, somehow, taken a flowery turn of late. The 1961 WJCC, for example, had the theme, "Extending Man's Intellect . . ." As may be noted readily by a quick search of past literature, this stands in contradistinction to the prosaic and pedestrian themes of only a few years ago. Of course, we know that the theme cited refers to man's ability to extend the usefulness and speed of his decisions, thoughts, etc. Yet, to the fourth estater, among others, the implication is there of "improving one's mind" or some such. The honorable psychomen who compose Stanford-Binet tests and like tortures have insisted for years that one may not improve his mind by bootstrapping, or any other known process. He may only learn more things in the pitiful mind he already has.

The mind improvers stand on firm ground, though. They are fully backed by the Kiplinger Washington Letter which has been confidently insisting for years that one may improve one's "business" mind, probably by sending in subscription money.

At any rate, the theme cited above does, somehow, leave the impression that those who use digital computers are "smarter" than those who do not. We all know this to be true, but we find it difficult to prove, formally.

Not all the heavy pressure to drive English back to the inflectional structure of Sanskrit or Lettish comes from the hardware side of the house. The softwares people have added their own inimitable obfuscation.

Enoch Mote traces the beginnings of software-talk back to the advent of the drum computer when the term "minimum latency programming" was devised as a simple way of saying "get things faster."

From this humble beginning we have progressed to the present day when "pseudo-code," "macro-language," and "debug time" are things spoken freely across the back fence by every housewife.

Cicero Beam feels that computer talk demonstrates a definite obscene trend. He cites such an example such as "Cleaning the heads." Usually, though, no one pays much attention to what Beam says.

With reference to the work of Jasper, Schaufel, Nattkarl, and others, one can, with ease, construct an undetectable facsimile of the typical public utterance output from a given computer shop. The following example will provide an illustration:

Kenesaw Mountain, Ga., September 5, 1961 - - - The COMPETING EQUIPMENT CORPORATION of AMERICA today demonstrated publicly for the first time a new concept in electronic data processing systems, designed to be utilized primarily in system processing utilizations involved in large-scale systems and systems processing applications. Utilizing solid-state circuitry representing a breakthrough in the state-of-the-art, the new system demonstrates the in-house technical ability that has made the Competing Equipment Corporation of America the acknowledged leader in the field of data processing system systems design and related fields of technical ability. Bruno Zorch, President of the Competing Equipment Corporation of America, described the new data processing system as, "A revolutionary breakthrough in the state-of-the-art." "Demonstrating completely asynchronous synchronism, for the first time in such a system," Zorch said, "the system makes full utilization of its inherent capability for minimum latency." "Utilizing solid-state devices with virtually no moving parts, this new system demonstrates a virtually instantaneous capability, approaching the speed of light," he said. "The in-house technical capability of Competing's engineers is well demonstrated in the design of this new system," Mr. Zorch noted. Kenneth McGreevly, Chief Sales Engineer for the Competing Equipment Corporation of America, described the programming systems to be utilized with the new system. "By the finest utilization of macro-language pseudo-codes in any system to date," McGreevly indicated, "our applications people, taking advantage of the inherent minimum latency of the system, have provided the user with the ability, when properly utilized, to run any five problems instantaneously." "Further," he averred, "all these systems, when utilized with this new system, are completely compatible."

The Competing Equipment Corporation of America, according to Mr. Bruno Zorch, President, intends to make its new system available for actual utilization on those applications in which such a system should be utilized in an eighteen to twenty month period from first delivery date.

EVER USES THINGS

ANY MORE ?

Those unfortunates familiar with the daily deluge of outpoop from Digitalelectronicland will immediately recognize the above sample as not in the cotton-picken least exaggerated. As a matter of fact, it is rather conservative in claims, format, and structure.

Actually, of course, the example given is not made up from the whole cloth, nor even the half cloth. It is a real, honest-to-gosh example, and it was written by Marvin Orfice when he was Director of Public Relations with Competing Equipment. Only the names have been changed to protect the innocent.

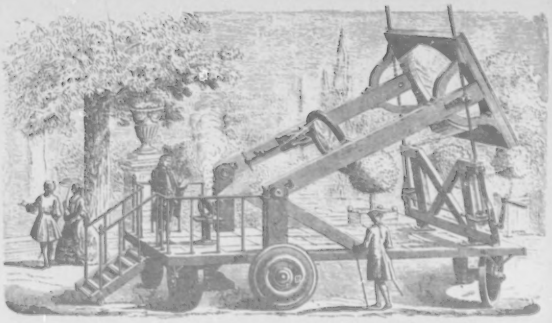
Mr. Orfice has never met K. B. Jasper.

NOTES

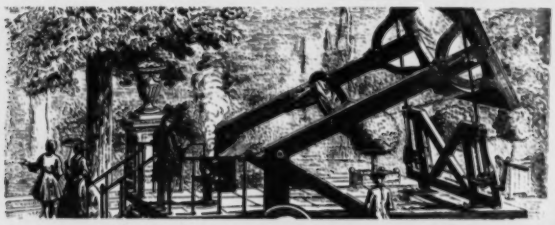
[1]K. B. Jasper, Emeritus Professor of Middle English, Abercrombie Institute.

[2]J. Alexander St. Georgé, Professor of Medieval History, Potts State College.

The Chaostron is a learning machine which incorporates several radically new design features. DATAMATION encourages a perceptive reading of this report which describes some results of experiments on Chaostron based on Case #14920-60, Technical Memorandum 59-1142-11.



a major advance in learning machines



THE CHAOSTRON

By J. B. CADWALLADER-COHEN, W. W. ZYSICZK and R. R. DONNELLY

The concept of the Chaostran developed from reported observations of animal learning behavior in stress-inducing situations. Two examples are especially worth citing.

Boosie[1] in 1948 studied the behavior of cats in an aqueous environment. Typically, a cat which is confined to a cage totally immersed in water exhibits an initial period of disorganized, apparently random action, involving great muscular activity. This pattern of behavior ceases, often quite abruptly, when the animal discovers that a state of reduced energy expenditure permits cessation of respiratory activity. That learning, in fact, takes place is unquestionable, since presentation of further stimuli does not cause the animal to return to its initial active (and ill-adapted) condition.

J. C. Gottesohn has reported strikingly similar findings in his monumental work[2] on the religious beliefs of chimpanzees. We differ from Gottesohn in the interpretation of some of his results, but the main points are clear; in a stressful situation, a period of random trial and error precedes the solution of the problem, and the solution is usually found quite suddenly, in its complete and final form.

This, then, provides the basis for Chaostron. The authors feel strongly that the key to successful automation of learning tasks lies in the randomization of the response pattern of the machine. The failure of various previous attempts in this direction, we feel, has been due to two problems; first, the difficulty of getting a sufficient degree of randomness built into the structure of the machine, and second, the expense of creating a device large enough to exhibit behavior not significantly influenced by the operation of any one of its components. We are deeply indebted to Dr. R. Morgan for a suggestion which showed us the way out of these difficulties; design for the Chaostron was done by taking 14,000 Western Electric wiring charts, cutting them into two-inch squares, and having them thoroughly shaken up in a large sack, then glued into sheets of appropriate size by a blindfolded worker. Careful checks were made during this process, and statistical tests were made on its output to insure against the propagation of unsuspected regularities.

Unfortunately, we have not, as yet, been able to complete the wiring of Chaostron. We felt, however, that it should be possible to estimate the effectiveness of Chaostron even before its completion by simulating it on a high speed digital computer. This procedure had the further advantage of attracting the interest of representatives of the Bureau of Supplies and Accounts of the United States Navy, who found in Chaostron an excellent aid to control of the Navy's spare parts inventory. The Navy, as a result, was generous enough to offer time on a BuShips computer for the simulation of Chaostron.

The computer of choice for the simulation runs was the IBM STRETCH machine, which not only operates at very high speed, but is also able to accept input programs coded in YAWN language, which closely resembles colloquial English. We felt it very important to use a source language for the simulation programs which would contain as much ambiguity as ordinary speech, since undue preciseness in specification of the simulation programs might accidentally "tip off" the machine to the nature of the desired solutions.

In any event, it was not possible to obtain a STRETCH computer for the project, and so the simulation was done by simulating STRETCH Chaostron on a 704. All simulation runs were conducted in essentially similar universes of environments; the computer was presented with a sequence of circles, squares and crosses represented by punched cards, and was required to print, after examining each stimulus, one of the words "circle," "square" or "cross." No reinforcement from the experimenter was provided, since it was feared that such reinforcement would bias the learning process, and thus vitiate the validity of any conclusions we might wish to draw from the results.

The first trials were run with the input stimuli represented on the punched cards as geometric patterns of punching in the appropriate shapes. As a control, one run was made with no stored program initially in the

run was made with no stored program initially in the machine, to check that the learning rate of the untutored machine was not so great as to interfere with further studies. For this run, the machine memory was cleared, the cards containing patterns were placed in the card reader, and the load cards button was pressed. After three hours, the machine had not printed its response to the first input pattern; evidently the rate of learning under these conditions is very low (we judge it to be on the order of 10^{-6} concepts per megayear).

Therefore, we proceeded with the main series of experiments, in which a random program was loaded into the computer ahead of each batch of data cards. A total of 133 random programs were tried in random sequence. Even in this series of experiments, the machine took a surprisingly long time to respond to the stimuli; in most cases the run had to be terminated before the first response occurred. However, on run number 73, the computer responded

***/ $ AX$,)U ,,,,,

to the first stimulus card (which was a square); on run 114, the computer responded

6666666666666666666666666666666

to every stimulus; and on run 131 the computer ejected the printer paper twice.

Unfortunately, budget difficulties forced us to abandon this approach after 133 trials, in spite of the promising appearance of the early results. Thus, our conclusions are perforce based on a smaller data sample than we would like. Nonethless, certain points are clear. ■

ACKNOWLEDGMENTS, ETC.

Our acknowledgments and thanks are due to Mr. J. B. Puffadder, for his assistance in the detailed design of Chaostron, and to Mr. V. A. Vyssotsky for manually simulating the 704 simulating STRETCH simulating Chaostron, to complete run 133 after the budget funds ran out. Thanks are also due to the Navy Department, which provided partial support for this project under contract NsRd-1BuS&A-111259.34a-GRQ1-77.C32. J. B. Cadwallader-Cohen, W. W. Zysiczk and R. R. Donnelly.

NOTES

1. The correlative reinforcement model of learning advanced by Dewlap, et al.,[3] is untenable in view of our results. No triphasic system could function without a degree of organization exceeding that which we have used in the simulation studies. Even this degree of structure, however, resulted in extremely slow response to comparatively simple stimuli.

2. It seems evident that further understanding of machine learning requires resynthesis in operational terms of the conceptual framework provided by the Liebwald-Schurstein-Higgins suggestion that memory traces are renewed by associative stochastic increments to ideometric pathways shared by stimulus-coupled functional elements.

3. Not only is machine learning possible, but in fact, it occurs under conditions of considerable difficulty. Indeed, it appears that even the simplest machines have a great amount of innate "curiosity" (where by "curiosity," of course, we do not mean to imply that anthropomorphic categories or judgments should be applied to machines, but merely that the machines have a desire to learn).

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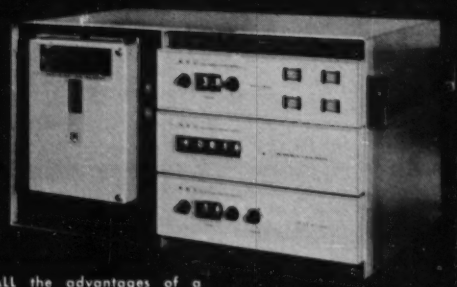

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CIRCLE 16 ON READER CARD

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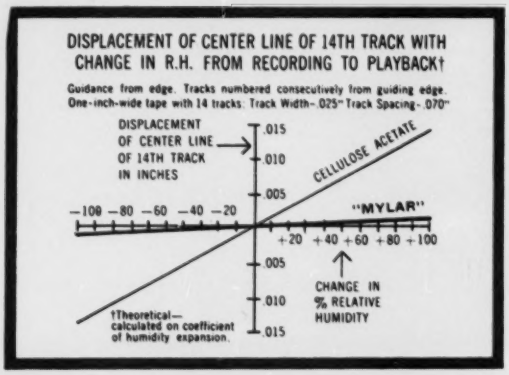
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Guidance from edge. Tracks numbered consecutively from guiding edge. One-inch-wide tape with 14 tracks. Track Width-.025" Track Spacing-.070"
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.005
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"MYLAR"
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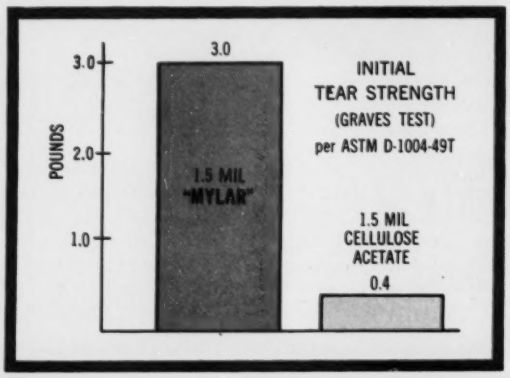
+20 +40 +60 +80 +100
.005
.010
.015
CHANGE IN % RELATIVE HUMIDITY
†Theoretical—calculated on coefficient of humidity expansion.



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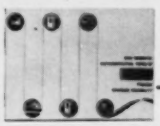

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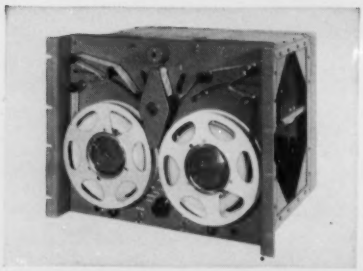

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CIRCLE 18 ON READER CARD

NEWS BRIEFS

H.S. STUDENTS PROGRAM 1620 IN 8 HOUR COURSE

An experiment, designed to find out whether a group of high school students experienced in the use of one computer could be introduced to a conceptually different computer in an accelerated course, has been completed. Sponsored by the Washington, D.C. chapter of the ACM in cooperation with the University of Maryland, 12 students were taught to program the new computer, an IBM 1620, in eight hours (four weeks, two hours per week), the remainder of the time spent pursuing special projects.

In preparation, last year, a course was given to 368 students, from which the 12 were selected, where they were taught to program the 709. In the advanced course, using the 1620, the students were given their first programming assignment and debugged it during the first meeting. The next three meetings covered classroom instruction and practice and the fifth meeting included a review of special machine features and FORTRAN. The final five classes were devoted to solving students' problems on the 1620. Total instruction time: 20 hours.

WESTINGHOUSE, REMRAND ENTER PROCESS CONTROL

A joint effort is underway by Westinghouse Electric Corp. and RemRand for the marketing of computing hardware for process control systems. Development programs will be headed up in the two companies by Paul R. Sprowl, manager of the industry systems department at Westinghouse and Dr. Valerius E. Herzfeld, manager of industrial computers at RemRand.

Westinghouse will supply complete systems including installation and related services, but will also continue with its independent research and development, as will RemRand.

CIRCLE 100 ON READER CARD

ALGORITHM DEVELOPED FOR CHEMICAL TRANSLATION

An algorithm using a newly constructed grammar of chemical nomenclature, developed by Dr. Eugene Garfield, director of the Institute for Scientific Information, Philadelphia, Penna., has produced a computer translation of chemical names directly to molecular formulas. Linguistic analysis and the logic of the program were verified using molecular formulas of several hundred randomly selected chemicals which were calculated successfully on a Univac I.

CIRCLE 101 ON READER CARD

NORTH AMERICAN LEASES THREE S-C 4020's

A $250,000-a-year leasing agreement for the delivery of three S-C 4020 high speed microfilm recorders to North American Aviation, Inc., has been made by the Information Technology Div. of General Dynamics/Electronics. The S-C 4020's will be assigned to research projects on the B-70 program, missile programs, and rocket engine research. Uses will include visual analysis of aircraft and missile wing-fuselage influence coefficients, plotting of trajectory data and construction of cost analysis studies.

CIRCLE 102 ON READER CARD

REMRAND, ROHR OFFER NUMERICAL CONTROL

An automatic part programming package for numerically controlled machine tools has been developed through the joint efforts of the Rohr Aircraft Corp. and the Univac Div. of Sperry Rand Corp. for Univac solid-state 80's and 90's. The complete software package will allow automatic part programming for the following numerical controls: Cincinnati, Numericord, ECS, Thompson Ramo Wooldridge, and Bendix.

After specifications of the part to be machined are given by an engineering drawing, appropriate information is transcribed in a manuscript which contains a minimum of information relating to part geometry, feed rates, spindle speeds and auxiliary machine tool instructions. Input cards are then punched utilizing the data on the original manuscript and are fed into the reader, which can read and verify up to 600 cards per minute, and then transmitted to the central processor.

Next, general part descriptions and tool instructions are interpreted, compiled and encoded, and the resulting output cards contain instructions for the control system of the machine tool which produces the part.

CIRCLE 103 ON READER CARD

MAJOR I.R. CONTRACT AWARDED FOR CRIS

A contract in excess of $500,000 has been signed by the Information Retrieval Corporation of Washington, D.C., for the manufacture of the Command Retrieval Information System (CRIS) by the Maryland Div. of Litton Systems, Inc. CRIS will store approximately 500,000 microfilm pages in a single cartridge and will retrieve any desired page or item in an average of 20 seconds.

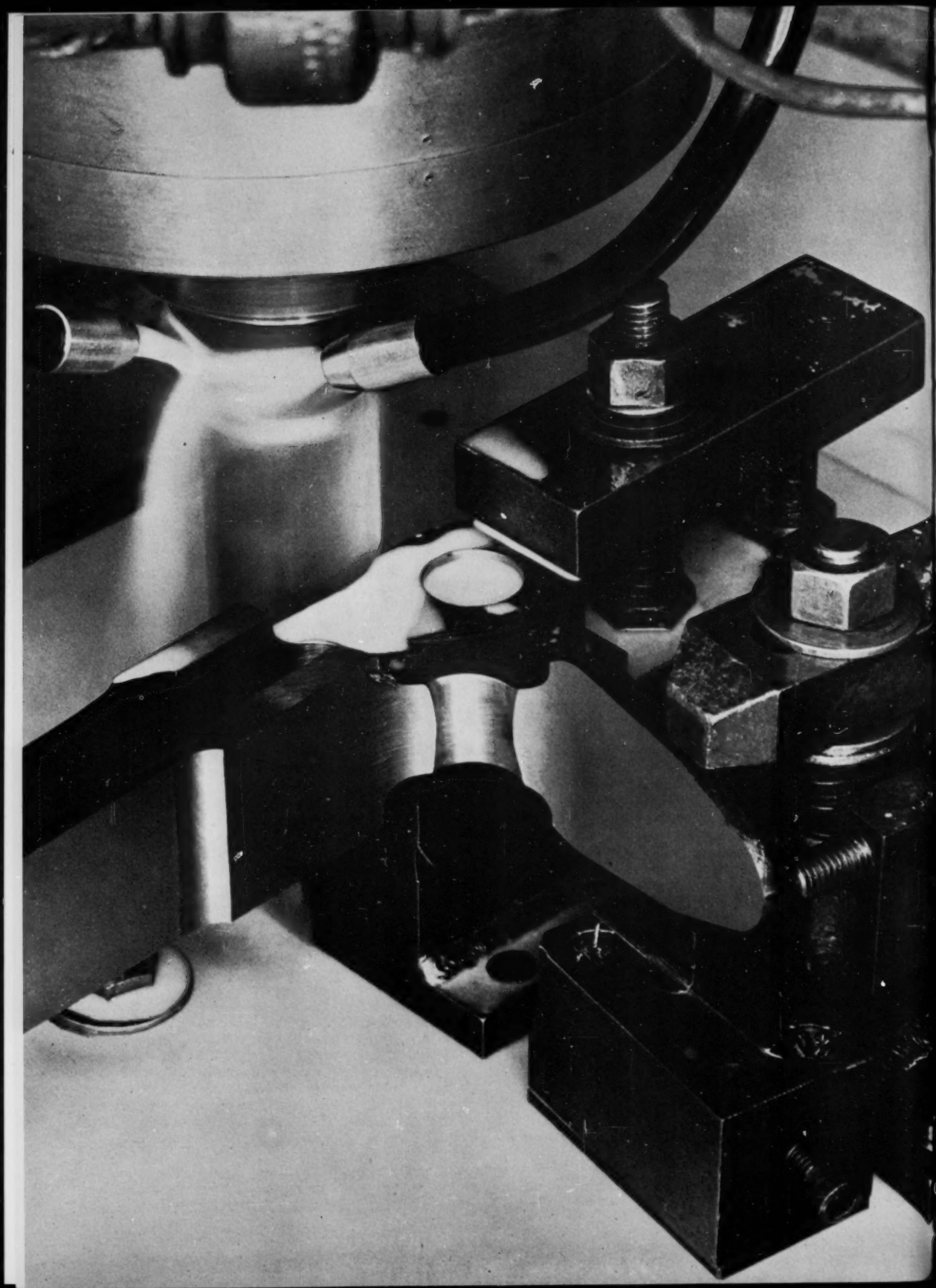
The basic unit can be expanded by the addition of equipment to provide automatic feeding of cartridges, electronic indexing and searching, in-

ALGOL PROGRAMS "COMPILE & GO" ON B220

ALGOL programs were seen compiling on a Burroughs 220 at just over the time required for on-line reading of the source program cards and on-line printing of the source statements at the Computing Laboratory of Cornell University. Since source programs can be recompiled at 50-100 statements per minute, object programs are seldom retained.

As an indication of what can be accomplished with such a system, it was found that sophomore engineering students were able to run a problem per week in a six-week introduction to computing. Stanford University has had similar experiences in "compile and go" on a Burroughs machine with an add time of 200 microseconds where the programs are read from cards. This achievement would not be possible if machine languages were taught, and would be impractical using FORTRAN because of the much longer compiling times, even if used on more advanced computers.

CIRCLE 118 ON READER CARD



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Rohr programmers simply describe in mathematical terms the shapes they want machined on a specific machine tool and the UNIVAC Solid-State automatically generates the control instructions that will guide the tool. *Result:* Thousands of metal parts of varied complexity turned out perfectly—and *economically*.

An aluminum upper engine mount, for instance, under conventional machine tooling, used to show a heavy scrap rate. Under numerical control with the UNIVAC Solid-State Computer, the scrap rate is now *zero*.

In one case, a three-dimensionally defined part was produced under numerical control at 1/40th the cost under conventional machining.

Rohr's over-all savings are as much as three to one, a saving of up to 66% on machining costs!

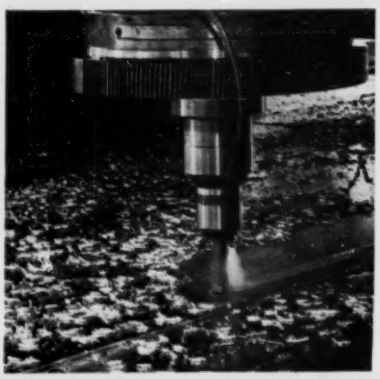
Here's what H. C. Emerson, Rohr Manufacturing Engineering Manager, has to say about the UNIVAC Solid-State Computer: "We chose the UNIVAC Solid-State because of its high storage capacity, fast processing speeds, low costs, availability and versatility. It not only handles our corporate data processing, but its application to numerical control has been extremely successful."

Yes, what's important to all industrial executives is that Univac offers a low-cost, medium scale, general purpose system that not only has proved itself in over 300 commercial installations but, at no additional cost, can handle with ease highly diversified numerical control part programs. Interested? Our local representative will gladly brief you on Univac Numerical Control—for your own installation or through your nearest Univac Service Center.

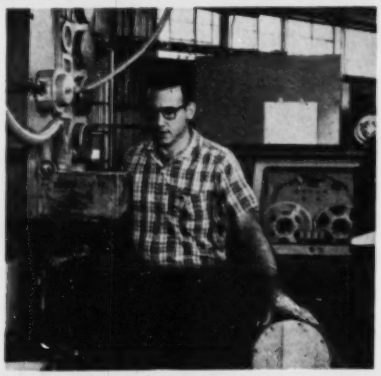
UNIVAC

DIVISION OF SPERRY RAND CORPORATION

UNIVAC Solid-State controls machining of three dimensional blowout door frame and engine mounting longerons.



Engine mounting box-beam for aircraft, milled from structural steel with help of UNIVAC Solid-State Computer.



Vacuum chuck being milled from aluminum plate with UNIVAC Solid-State produced data.

How Convair-Astronautics keeps track of this...

(and 84,999 other missile parts)

The Manufacturing Control Department at Convair (Astronautics) Division of General Dynamics Corporation has a monumental problem: how to keep track of the movement of over 85,000 individual missile parts.

The solution: *automated data preparation* by means of a Friden Collectadata® system. Situated in key plant locations, Collectadata transmitters report virtually all parts movements—over 5000 every day—to central Collectadata receivers which record them into punched paper tape. At day's end the Collectadata tapes are fed into the electronic computer at Astronautics for further data processing.

This is what Astronautics says: *"The Collectadata has been in use at Astronautics for less than a year. But by eliminating tedious manual paperwork, and by assuring prompt processing of all inventory reports, it has already saved considerable time, trouble and money."*

How much could Collectadata save you? Call your Friden Systems Man, or write: Friden, Inc., San Leandro, California.

THIS IS PRACTIMATION: automation so hand-in-hand with practicality there can be no other word for it.

Friden

Sales, Service and Instruction Throughout the U.S. and World

CIRCLE 19 ON READER CARD

NEWS BRIEFS . . .

stantaneous enlargement and reproducton of microfilmed pages, and transmission of information from a central file to remote locations.

CIRCLE 108 ON READER CARD

● Computer Oriented Research and Engineering, Inc. (CORE, Inc.) is a new organization established to provide business and scientific groups of western Pennsylvania and Ohio computer time by the hour. The firm has purchased a 704 with 10 tape units. George Burns and Joseph Brashear are president and vice president, respectively.

CIRCLE 104 ON READER CARD

● Responsibility for physical planning, design, engineering and construction of a computer site is now offered by the Computer Service Co., Los Angeles. An attempt is made to forecast needs of the prospective user, and thus provide at time of delivery of the computer, a site conducive to maximum computer performance.

CIRCLE 105 ON READER CARD

● Audio Devices, Inc. has been awarded a second decision against the Armour Research Foundation of Illinois Institute of Technology in a six year court battle concerning a magnetic tape patent.

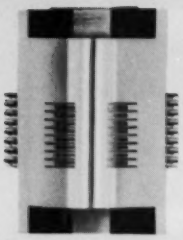
● The Service Bureau Corp. has opened its first electronic banking center offering MICR reader-sorter equipment on a contractual basis. Pacific State Bank, Hawthorne, Calif., is the first to use the MICR service. In less than two hours each evening an IBM 1210 reader-sorter handles more than 11,000 checks received daily at the bank's three branches. The checks are returned the next morning.

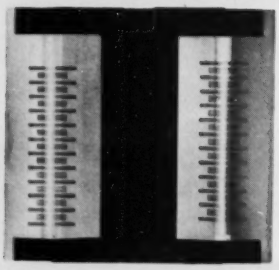
● Univac, St. Paul, has received a $1,046,000 letter contract from the Navy's Bureau of Ships for production of peripheral equipment for the Naval Tactical Data System. The firm has received three additional contracts totaling $1,161,390 for the production of computers and peripheral gear for the system.

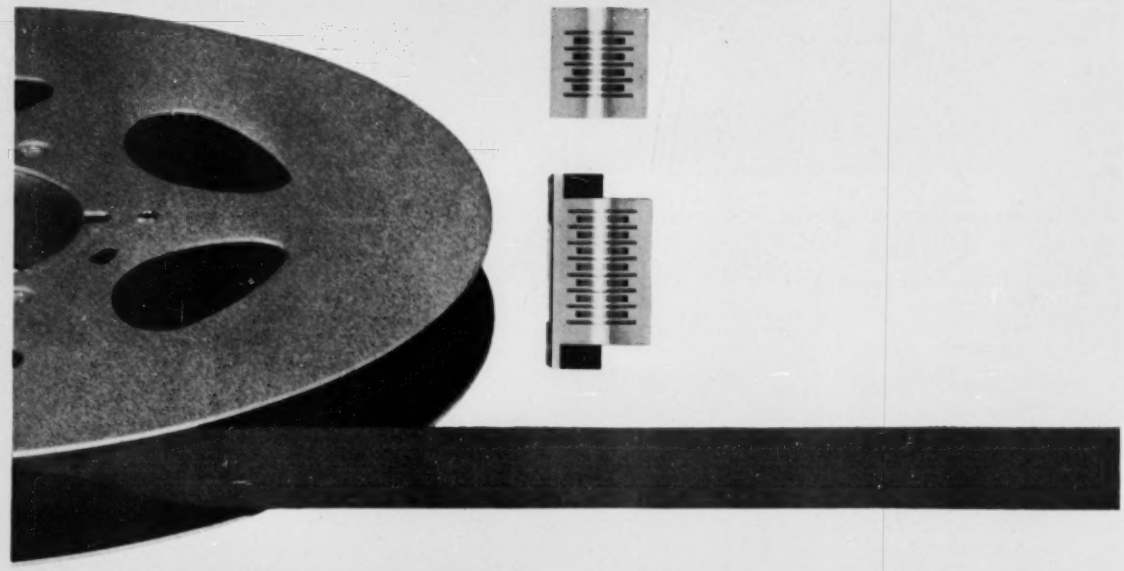
● Neisner Brothers, Inc., has installed a UNIVAC 90, which is the first computer to be used in variety chain operations. The 90 will handle 12,480,000 billings, 416,000 combined payroll records, and a total unit volume of 19,116,000 transactions per year.

● The IBM Corp. has announced an internal increase in operating speeds of more than 15% for the 7080. A reduction in the cycle time of the

standard heads by Brush fill 90% of all Magnetic Head Applications







Why such an all-out claim? Because only Brush has kept pace with the many design requirements in recording technology. Continuous analysis of current and future trends enables us to maintain a design improvement program incorporating all field-proven advances in our *standard* heads. It's a must . . . to satisfy *all* customer requirements. The result? We've been able to standardize and meet all but a few highly specialized applications. You save engineering and testing time . . . and money. If you're one of the few with a "special" problem, Brush obviously has the engineering capability and manufacturing facilities necessary to fulfill *your* magnetic head application. With both standard and special heads, detailed mechanical drawings and specifications plus actual electrical characteristics are available *before the fact*. You can accurately predict system performance without costly time-consuming tests. *Write now for our design and specification bulletin "Optional Characteristic Heads".*

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

News Briefs . . .

central processing unit from 1.09 to one microsecond, plus a new programming instruction which doubles the speed at which information is moved within core storage are the two factors resulting in improvement of the 80.

CIRCLE 106 ON READER CARD

● GUIDE International will hold its next meeting at the Netherlands Hilton Hotel, Cincinnati on Nov. 8-10. For information contact E.F. Cooley, Planning & Development Dept., Prudential Insurance Co., Newark, N.J.

● The American Medical Research Foundation is sponsoring a program to reduce newborn deaths through evaluation of medical data collected by a UNIVAC solid-state, which makes possible correlation of data on 150,000 deliveries in hospitals scattered throughout the country.

● Minneapolis-Honeywell has arranged to use Farrington Manufacturing Company's optical scanning equipment on their EDP systems. Honeywell will incorporate the scanners as a customer option in its EDP systems to provide an automatic on-line input for the 800 and 400.

● The Bendix Computer Division has devised a new approach to project planning similar to the Navy's Program Evaluation Review Technique (PERT) and the Air Force's Program Evaluation Procedure (PEP), which will permit automatic planning, scheduling, estimating and control of engineering, construction and development projects, to be made available to small business and industrial firms.

● To the users of the RCA 501 system, the PERT method for planning, checking and controlling business and scientific projects is being offered as a free "package." This method is the one used by the Navy and Air Force for administering their large-scale development programs.

● According to Digitronics Corp., Dial-o-verter systems which transmit data over regular telephone lines at speeds up to 1,500 words per minute, will have been installed in 17 cities from coast to coast by the end of the year.

CIRCLE 107 ON READER CARD

● The National Aeronautics and Space Administration has purchased a technique for integrating orbits of artificial satellites using the IBM 704, from Computer Usage Co., Inc., resulting in a program requiring less than 42 milliseconds per time step. The program was developed privately by CUC, not under government contract.

● Computer Concepts, Inc., a new computer programming development firm, has agreed to represent Bonner & Moore Engineering Assoc. of Houston, Texas, to potential customers in the fields of operations research and process control analysis.

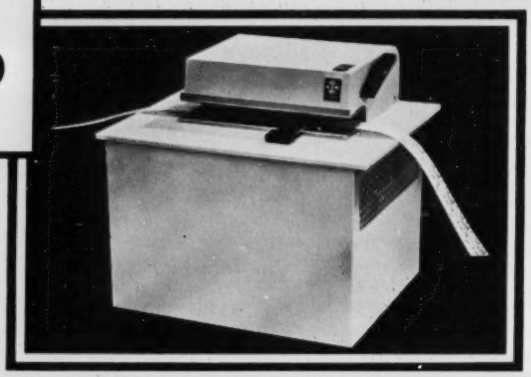
● The 50-member trade association formerly known as Office Equipment Manufacturers Institute (OEMI), has changed its name to Business Equipment Manufacturers Association (BEMA), and has moved its headquarters to the Pfizer Building in New York City.

● Optional circuitry increases the overall job speeds of the solid-state IBM-1401 computer by as much as 20 percent via a new processing overlap feature which enables the computer to perform its computations simultaneously with a wide range of input/output functions.

CONTROL DATA

High Speed Punched Paper Tape Reader

350



COMPUTERS
BUSINESS MACHINES
DATA REDUCTION
DATA PROCESSING
MACHINE CONTROL
INDUSTRIAL CONTROL

- Unsurpassed Reliability
- Advanced Mechanical Design
- 350 Char/Sec Read Rate
- Start-Stop or Continuous Mode
- 5, 7, or 8 Level Tape
- Tape Widths: 11/16", 7/8", 1"
- Instantaneous tape width selection
- Reads all punched tape
  Paper-Plastic
  Colored-Plain
  Oiled or Non-oiled
- Complete freedom from programming limitations

The Control Data Model 350 Paper Tape Reader employs the most advanced tape controls and reading techniques. Multi-colored tapes can be read interchangeably without the need of bias adjustments, and new specially designed light guides in the reading head eliminate dirt collecting holes. The precise control system eliminates troublesome resonances and provides complete freedom from programming limitations. These and other features combined with careful attention to details and quality, result in a paper tape reader which provides new high standards of reliability and versatility.

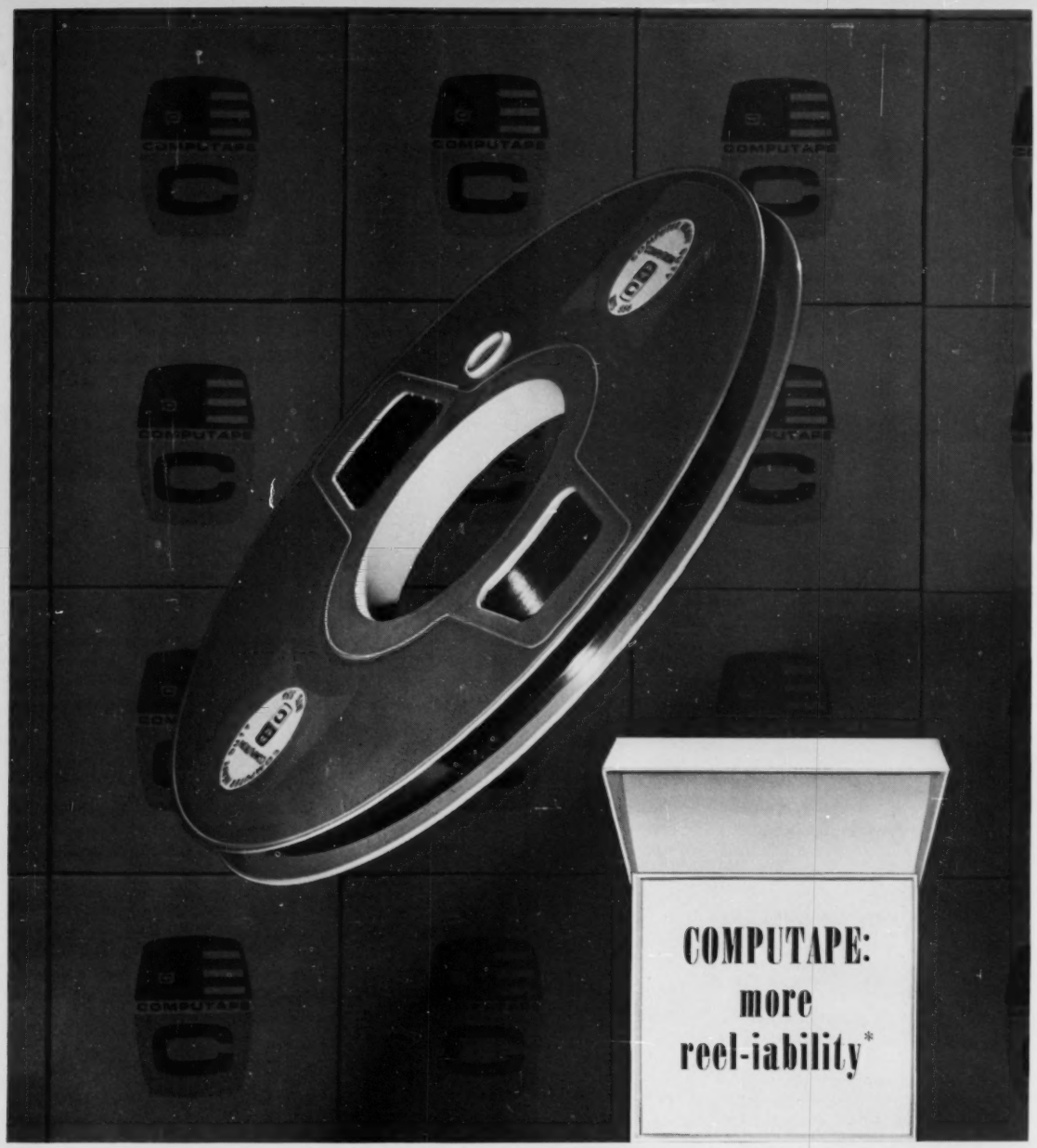
For complete specifications, prices and delivery write or call us directly or contact our nearest sales representatives.

CONTROL DATA CORPORATION

CEDAR ENGINEERING DIVISION

TWX-MP 974 • 5806 36th St. West • Minneapolis, Minn. • WEst 9-1687

CIRCLE 21 ON READER CARD



***REEL-IABILITY** — that quality in tape which reduces computer down-time and operating costs . . . which guarantees (repeat, guarantees) 556 bits per inch with no dropouts in your severest applications. This kind of reliability (no matter how you spell it) you find only in new Computape, a truly premium quality heavy duty computer and instrumentation tape.

COMPUTAPE: the facts

Computape utilizes a new, heavy-duty coating applied to proven Mylar* backing. This revolutionary formulation combines extra heavy duty usage with minimum of wear products. Highly conductive coating prevents accumulation of static charges. Magnetic properties are specifically designed for high density, high resolution data recording, with binders carefully selected to assure non-aging.

Manufactured start-to-finish in completely controlled dust-free facilities (our plant is, as far as we know, the world's newest) Computape is the product of the only company devoted exclusively to the manufacture of quality tapes for data processing and instrumentation.

Investigate Computape today. Better still, immediately.

COMPUTRON INC.

122 Calvary Street, Waltham, Massachusetts

*T. M. DUPONT

CIRCLE 22 ON READER CARD

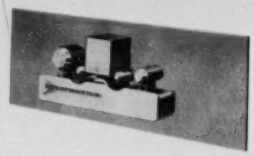
For a Complete Line of
Perforated Tape Equipment

DIGITRONICS

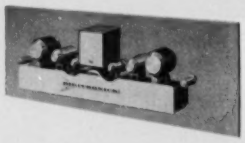
High Speed, All Solid State HANDLERS and PHOTO-ELECTRIC READERS

No matter what your requirements . . . whether for use with digital computers, machine tool controls, ground support or other instrumentation . . . 8 basic Dykor® models each of modular design allow Digitronics to tailor its equipment to meet your specific requirements. All solid state construction for years of low maintenance operation. Speeds from 50 to 2,000 characters per second, 5 to 8 level interchangability, dual speed motors and many other Digitronics options.

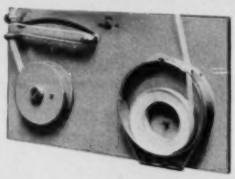
See your local Digitronics representative or write for full technical information to:



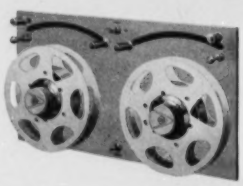
MODEL 3500 Uni-Directional Reader. Speeds to 2000 cps. Stops before the following character at 1000 cps.



MODEL B3500 Bi-Directional Reader. Speeds to 1000 cps. Stops before the following character at 1000 cps.

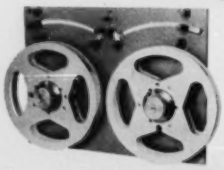


MODEL 4544 Uni-Directional Tape Handler. For use with model 3500 readers. Handles 500 feet of 5 to 8 level tapes interchangeably at speeds to 500 cps.

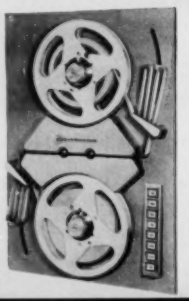


MODEL 4577 Bi-Directional Tape Handler. Handles 500 feet of 5 to 8 level tapes interchangeably at speeds to 500 cps. Rapid rewind at 1000 cps.

MODEL 4566 Bi-Directional Tape Handler. For use with model 3500 or B3500 readers. Handles 500 feet of 5 to 8 level tape, in either direction, at speeds to 400 cps. Rapid rewind at 1000 cps.



MODEL 4599 Bi-Directional Tape Handler. Handles 1000 feet of 5 to 8 level tapes interchangeably at speeds to 250 cps.



MODEL 4500 Integrated High Speed Bi-Directional Reader. Full servo reel control. Speeds to 600 cps. while handling 1000 feet of 5 to 8 level tape. Integrated electronics chassis contains vacuum tube reel servos, solid state controls and channel amplifiers.

DIGITRONICS CORPORATION
Albertson Ave., Albertson, L. I., New York • Area Code 516 HT 4-1000

NEW PRODUCTS

modular data integrator

A modular data integrator produces a "common language" perforated tape which sequentially combines fixed data, identification data and time and count data for business machines, tabulators and computers. The unit

can be used with any standard dp equipment, and will accept any existing punched cards. AMERICAN DATA MACHINES, INC., 7 Commercial Road, Hicksville, L.I., N.Y. For information:

CIRCLE 200 ON READER CARD

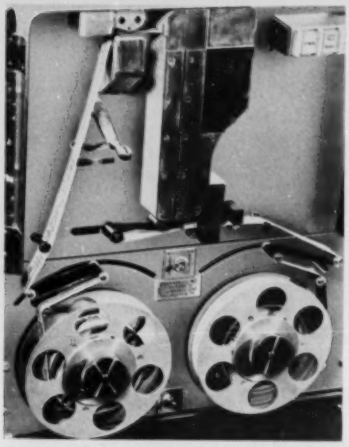
industrial control computer

A new industrial control computer, the RW-330 performs addition instructions in 260 microseconds, including minimum access time; has a 28 bit word length, and a memory capacity that can be supplied from 4,000 to over 100,000 words. The RW-330 is applicable in the control of chemical plants, refineries, nuclear and steam power plants. TRW COMPUTERS CO., A DIV. OF THOMPSON RAMO WOOLDRIGE, INC., 8433 Fallbrook Ave., Canoga Park, Calif. For information:

CIRCLE 201 ON READER CARD

paper tape devices

Omni-Data, a new line of I/O devices, employs a new technique by which information is stored on the surface of the paper resulting in a flexible, no-impact, no-contact system. Two basic units have been developed to aid in this approach: the Omni-Data recorder, which electrostatically records permanent visible spots on the tape; and the Omni-Data reader, which uses the principle of chopped, reflected light to interpret spots or holes in the tape.



Omni-Data features speeds in excess of 1,000 characters per second, high density recording, and the ability to read all types of tape, interchangeably, without modification of the equipment. This device is applicable in the fields of ground support equipment, large scale digital data handling equipment, low cost digital computers, etc. OMNITRONICS, INC., A SUBSIDIARY OF BORG-WARNER, Philadelphia, Penna. For information:

CIRCLE 202 ON READER CARD

photocell reader

A high-speed photocell reader, the RR-300, reads punched tape at the rate of 300 characters a second and is applicable in dp and process control. The sensing element is one piece of silicon containing eight information and one timing track channel which eliminates focusing problems. The reader is available as either a desk top or rack mounted unit. RHEEM MFG. CO., ELECTRONICS DIV., 5200 W. 104th St., Los Angeles 45, Calif. For information:

CIRCLE 203 ON READER CARD

synchronous generator

The SG-46 is a synchronous generator which accepts a randomly timed, arbitrarily shaped input pulse, which may be obtained from various equipment including a paper tape reader, magnetic tape read amplifier or relay switch. The pulse is then converted into one properly timed and shaped pulse which is the same as standard wave forms used in H-PAC families. Outputs of assertion and negation have a driving capability of six unit loads per output at 16 MC. A negative-going waveform of four volts, with a fall time of 2.7 μ s, is the slowest ac coupled input signal which the SG-46 will recognize and convert. COMPUTER CONTROL CO., INC. 983 Concord Street, Framingham, Mass. For information:

CIRCLE 204 ON READER CARD

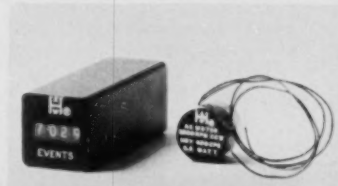
germanium multiple diodes

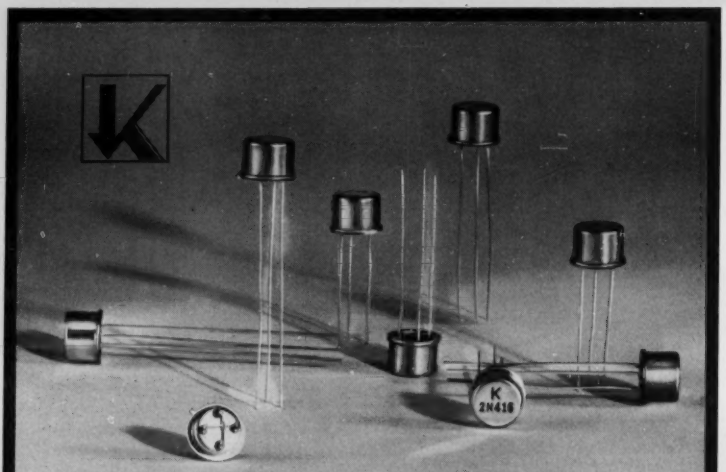
New multiple germanium switching diodes consist of two and three semiconductor diodes of advanced technology, packaged as single, integrated units. By reducing the number of separate components and electronic connections needed in construction, the assembly of computers is expected to be far simpler and less costly. Characteristics of multiple diodes include forward voltage drop at five milliamperes – 0.4 volts maximum; reverse breakdown voltage -20 volts; reverse current at -2 volts, 55° C junction temperature -15 microamperes maximum; and a recovery time of 0.25 when switching from 20 milliamperes forward current to six volts reverse bias. RCA, 30 Rockefeller Plaza, New York 20, N.Y. For information:

CIRCLE 205 ON READER CARD

microminiature starts counter

A digital starts or events counter, microminiature in size, operates from a 28-volt DC source and is only one-half inch square by $1\frac{9}{16}$ inches long. The instrument employs a four-digit drum counter which has a range of 9999 events or starts and can record





KEARFOTT TRANSISTORS PROVIDE HIGH RELIABILITY-CONSISTENT PERFORMANCE

HIGHEST POWER DISSIPATION OF ALL AVAILABLE GERMANIUM ALLOY-JUNCTION TRANSISTORS

Kearfott now offers a complete off-the-shelf series of TO-5 germanium PNP-alloy junction transistors. Their unexcelled electrical and mechanical reliability, precise electrical characteristics, and virtual insensitivity to temperature changes derive from Kearfott's intensive materials-and-methods control, plus complete, 100% functional testing. These factors add up to the consistent reliability, uniformity, extended service life, and repeatability of product performance which typify Kearfott semiconductors.

DESIGNED AND PRODUCED BY KEARFOTT SEMICONDUCTOR CORP. WEST NEWTON, MASS.

CHARACTERISTICS

Designed to meet or exceed requirements of NAVORD OS9669B (CR-212 Series) and MIL-S-19500D

All transistors tabulated below are available with maximum collector power dissipation of 200 mw.

2N123/5	2N404A	2N520	2N653
2N315	2N413	2N520A	2N658
2N315A	2N414	2N521	2N659
2N316	2N414A	2N521A	2N660
2N316A	2N414B	2N522	2N661
2N317	2N416	2N522A	2N662
2N317A	2N417	2N523	2N1017
2N394	2N425	2N523A	2N1018
2N395	2N426	2N578	2N1303
2N396	2N427	2N579	2N1305
2N396A	2N428	2N580	2N1307
2N397	2N519	2N581	2N1309
2N404	2N519A	2N582	

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

CIRCLE 24 ON READER CARD

NEW PRODUCTS . . .

such events as how many punch cards have been inserted in the system, how many times each department uses the machine, or how many times the installation has been started or stopped. A. W. HAYDON CO., Waterbury, Conn. For information:

CIRCLE 206 ON READER CARD

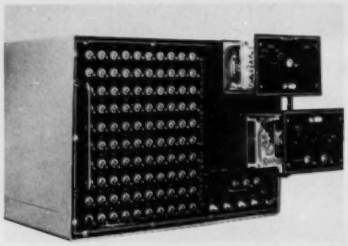
encoder readout systems

A new encoder readout system particularly applicable on comparator units, contains three separate discs in each encoder unit. The first has 1000 parts per turn, while the second and third each have 100 parts in a turn. The encoder has a potential resolution capability one part in 107. For every five turns of the encoder, the leadscrew rotates once and moves 1 mm. which means a measurement of 5000 parts in one mm. WANG LABORATORIES INC., Natick, Mass. For information:

CIRCLE 207 ON READER CARD

digital pattern generator

The digital pattern generator, a completely transistorized test instrument, will test and check the circuit and subsystem development of computers, data logging systems, etc. The D.P.G. can also be used in control system



testing and study, teaching binary arithmetic, study of computer logic, programming stress tests and in basic logic and digital courses. MAGNAVOX, GOVERNMENT AND INDUSTRIAL DIV., Urbana, Illinois. For information:

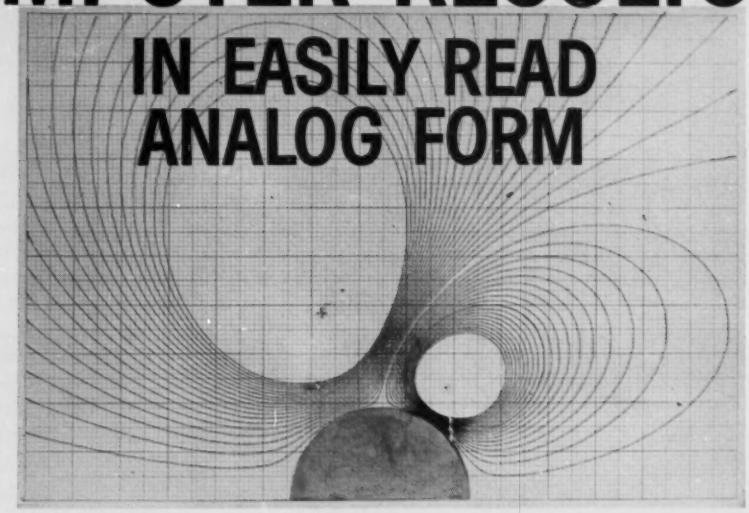
CIRCLE 208 ON READER CARD

memory for analog

Microstore, the memory component used in a general purpose analog computer, can store answers or values to problems for presentation later when the operator wants to compare new values to those previously computed. This new component adds a high-speed memory storage capability and can store two values at a time in one memory package for recall. Without disturbing the use of existing summing amplifiers, up to 10 Microstore components, each with two storage units, can be plugged into an

PLOT COMPUTER RESULTS IN EASILY READ ANALOG FORM

With Dymec Data Reduction Systems



You can make X-Y or strip-chart recordings from digital data at rates of up to 100 conversions per second with Dymec digital-to-analog conversion techniques. Data recorded at computer speeds on magnetic tape, punched cards or punched tape can be automatically plotted at slower speeds for visual examination and analysis. Additional data can be entered manually with an auxiliary keyboard.

Two moderately priced Dymec Data Reduction Systems are available. One extracts data from magnetic tape; the other is used with punched cards, punched tape or typewritten records. These systems include three types of digital-to-analog converters which are also available separately or as building blocks for custom designed data reduction systems.

DY-6575, A complete system, magnetic tape to X-Y recording

You can increase the efficiency of your high-cost computer with the DY-6575 Magnetic Tape Plotting System. Tape written at 75 inches per second on the computer is read at 3 inches per second for recording. The Dymec system makes 100 conversions/second from digital data on magnetic tape for continuous plotting on a Moseley Autograf Recorder. Accepts binary or BCD inputs, includes search mode and visual display for check-out or calibration. Overall accuracy of plotting system, ±0.2% of full scale. Complete system about $29,750.00.

DY-6242, A complete system, punched cards, punched tape or keyboard to X-Y recording

Plotting speeds of 50 points per minute with punched cards and 80 points per minute with punched tape are yours with the DY-6242 Plotting System, which also is supplied with a 10-key serial entry keyboard for recording tabular data. Overall accuracy of plotting system, ±0.2% of full scale. The Dymec system consists of a digital-to-analog converter, a tape reader and a Moseley Autograf Recorder with character printer. Complete system about $8,700.00.

Three digital-to-analog conversion building blocks

Dymec Model 2742 Digital Data Translator accepts data from IBM cards, perforated paper tape or a serial keyboard and converts for recording up to four decades of data plus a sign for each axis. The transistorized instrument provides a front-panel display for monitoring translator contents, plus controls for calibration, single cycle or automatic operation. D/A conversion accuracy, 0.1%. Price, including manual keyboard, about $4,500.00.

Dymec Model 2743 Series Digital/Analog Converters accept binary, binary-coded-decimal or decimal data for conversion to analog voltages. Up to four channels in one unit. Each can process up to 12 bits of binary, up to 4 decades BCD or decimal data. Price about $3,800.00.

Dymec Model 2744 Series Magnetic Tape Units include tape control unit and tape converters for recording binary and binary-coded-decimal data. The control unit, Model 2744A, accepts data from tape and provides an output to drive one of the converters, Model 2744B for binary data and Model 2744C for BCD data. Price, about $14,700.00, including 2744B or 2744C Converters.

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Call your Dymec/Hewlett-Packard representative or write direct for information on Dymec digital-to-analog conversion capabilities.

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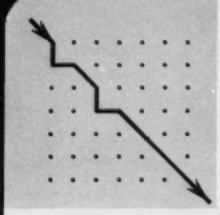

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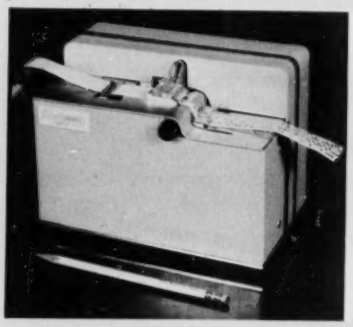
NEW PRODUCTS . . .

EAI PACE 231R general purpose analog computer. ELECTRONIC ASSOCIATES, INC., Long Branch, New Jersey. For information:

CIRCLE 209 ON READER CARD

motorless paper tape punch

The P-100, a motorless, direct-drive paper tape punch will perforate any 5, 6, 7, or 8 hole tape at rates up to 20 characters per second. The punches are activated by solenoids,



and a restoring bail gives positive return. In standby operation, no current is drawn and no parts are in motion. INVAC CORP., 14 Huron Drive, Natick, Mass. For information:

CIRCLE 210 ON READER CARD

alphanumeric dp system

The series E desk-size computer has been integrated with a 10-total typewriter accounting machine offering a business dp system, with alphanumeric capability, and eliminating the need for additional units to write descriptive information on accounting forms. Output can be either by a card punching or tape device, or both. BURROUGHS CORP., EQUIPMENT AND SYSTEMS DIV., Detroit 32, Mich. For information:

CIRCLE 211 ON READER CARD

tape preparation system

Tapemaker, a typewriter-operated paper tape preparation system, uses photoelectric encoding techniques, eliminating all electrical and electro mechanical encoding matrices, contacts and switches. Other features include a motorless direct-drive paper tape punch, all solid-state circuitry on printed circuit boards, dual key logic and an automatic keyboard interlock. INVAC CORP., Natick, Mass. For information:

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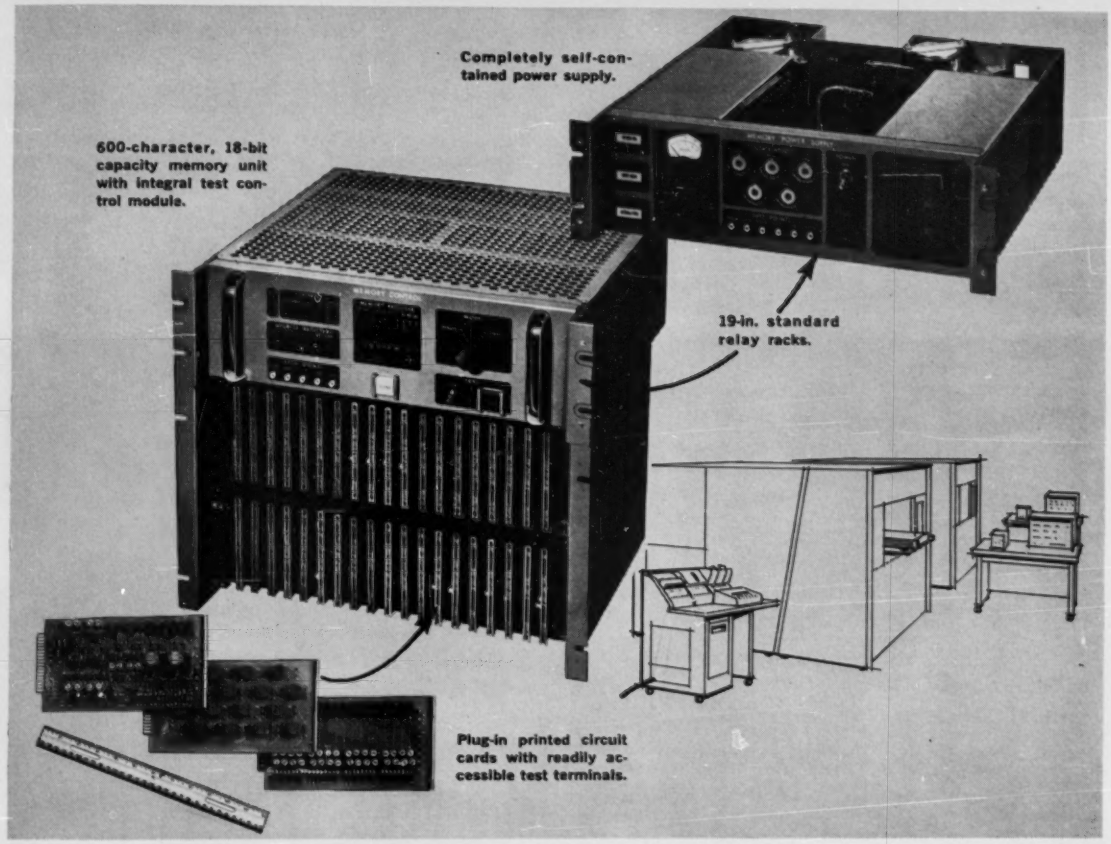
portable data gathering

A portable data gathering system, the S-3100, records analog test data for direct entry to a computer and

From General Ceramics Division of
INDIANA GENERAL CORPORATION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This remarkable system can tally 10 hand-marked paper ballots every second — providing complete election results from an average Los Angeles precinct in less than a minute.

According to Jerome Nishball, Norden Project Engineer, "GC's memory system was chosen primarily because of the compactness of design which permitted us to reduce the *overall size* of our electronic equipment by 20 percent — this saving alone was significant even without considering GC's very competitive price."

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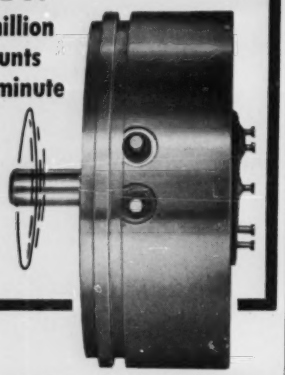

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provides the full dp capabilities of large-scale, multi-rack, fixed installations. The unit, which weighs less than 153 pounds, will accept up to 100 analog voltage inputs and records them in exact digital format without intermediate transcription. EPSCO INC., 275 Massachusetts Ave., Cambridge, Mass. For information:

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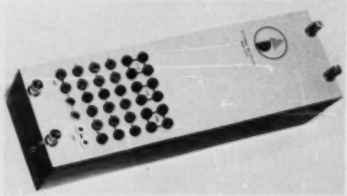
analog multiplier

Model 160 analog multipliers are available as separate components for expansion of other DC analog systems operating between ±100 volts, or as independent units. The 160 can



be used for multiplication, division, squaring or extracting square roots. APPLIED DYNAMICS, INC., 2275 Platt Rd., Ann Arbor, Michigan. For information:

CIRCLE 214 ON READER CARD

New Products . . .

low speed perforator

The LP-2, low speed tape perforator, operates at punching speeds up to 120 codes per second. The straight line input was chosen to allow introduction of an additional punch which contains a high-speed print station adjacent to the punch and die assembly. Sixty-four different symbols can be printed at the rate of 100 characters per second with printing positioned just above sprocket holes. SOROBAN ENGINEERING, INC., Box 1717, Melbourne, Florida. For information:

CIRCLE 215 ON READER CARD

tape switching

For magnetic tape operations in solid-state computer installations, a new tape switching console, the 7155, permits the alternating of a tape unit's "affiliation" between two computers, two tape channels of a single computer, or between a computer and an auxiliary tape I/O system. The 7155 can control up to eight 729II or IV magnetic tape units and four panel keys control each unit. Average rental is $395. IBM, 112 E. Post Rd., White Plains, N.Y. For information:

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Celanese Corporation of America is intensifying the utilization of mathematically-based scientific disciplines for its engineering, manufacturing, product distribution and management decision-information activities. A small but select group of professional specialists is now being formed for this effort.

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They will work as internal consultants between top management and the line and staff employees responsible for sales forecasts, production schedules, process operation and control, inventory and quality control, and the transportation of product to customer. These and related activities are complex and often require the use of high-speed computers. They demand the highest order of ability in problem definition and solution.

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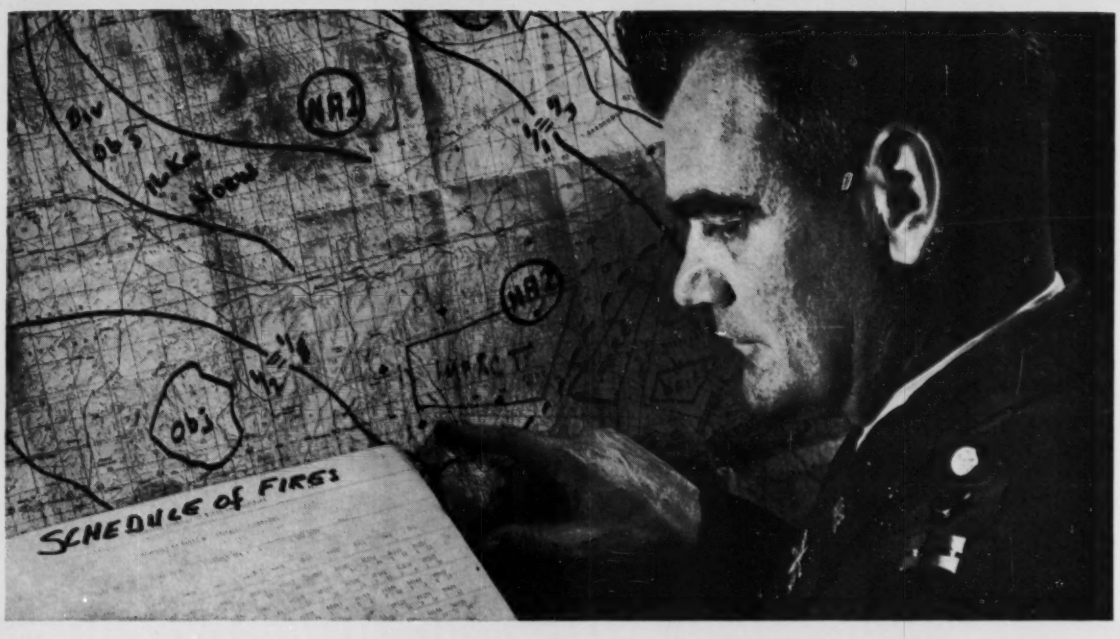

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Targets to destroy... troop movements to cover... a bridge to save... a gun emplacement to wipe out... a precisely coordinated schedule of firepower and manpower and brainpower.

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At recent exercises, an Army-Industry team successfully demonstrated that automatic data processing systems can help to reduce the time it takes to prepare a Divisional Fire Plan from a matter of hours to a matter of minutes. When computers process ballistic solutions at electronic speeds, they aid in achieving first-round target hits. This means saving ammunition—conventional or nuclear. It also means surprise—hitting the target while it is unprepared and vulnerable. The long-range program of developing Command Control Information Systems is now being extended to other Tactical Field Army functions, utilizing the FIELDATA family of equipment.

Development and testing of artillery fire planning and control systems are being done by the U.S. Army Electronic Proving Ground, Fort Huachuca, Arizona, with the cooperation and support of the U.S. Army Artillery and Missile School, Fort Sill, Oklahoma. Technical assistance is being provided by Ramo-Wooldridge, a Division of Thompson Ramo Wooldridge Inc.

Challenging openings now exist at Ramo-Wooldridge's Fort Huachuca office for experienced computer programmers, systems analysts and test and applications engineers. All qualified applicants will receive consideration for employment regardless of race, creed, color or national origin.

Contact Mr. R. L. Eddy at

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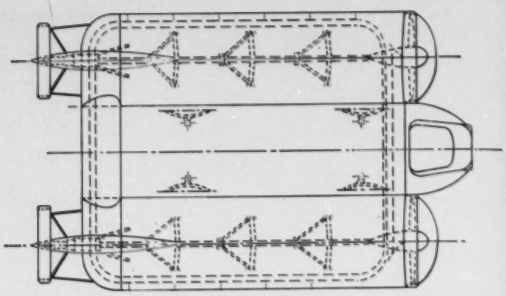

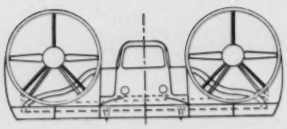

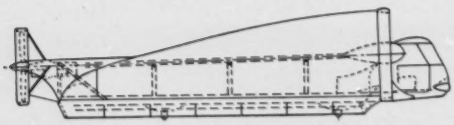

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The smaller of the two Aeronutronic-designed vehicles will weigh 8,000 pounds, carry a 2½ ton payload, cruise at 40 mph. It will have a range of 100 miles and a grade capability of 30%.

The big machine is a high-speed, heavy duty carrier. Weight: a hefty 44,500 pounds, payload: 22,000 pounds, speed: a fast 80 mph, range: 300 miles. It, too, will have a grade capability of 30%.

In spite of this evidence of accomplishment, Aeronutronic's work in the field has just begun. Army Transportation Corps and Navy contracts are speeding further studies into the potentialities of the new vehicle. The ACV is destined to play a significant role in future military and civilian transportation.

Further information regarding the air cushion vehicle, as well as other exciting projects in work at Newport Beach, may be had by writing to Aeronutronic.

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MIT introduces
COGO
for programming in civil engineering

COGO, a new computer programming system, allows engineers to write instructions in the technical language of the civil engineering profession. The name of the system was derived from Coordinate Geometry, the mathematical basis for the system, and can be applied to all computation problems related to points and lines in space, but can also be expanded to include various other problem areas. It was developed by Professor C. L. Miller, director of the Civil Engineering Systems Laboratory at MIT.

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The design of the COGO system was based on an analysis of the practical problems involved in using computers on civil engineering projects, and it was found that most geometric problems could be reduced to two fundamental operations: compute the coordinates of points given various sets of information such as offset from a known point to a curve; and compute the length and direction of lines between known points. COGO gives the engineer complete control over the sequence of such operations and the form of input/output. ■

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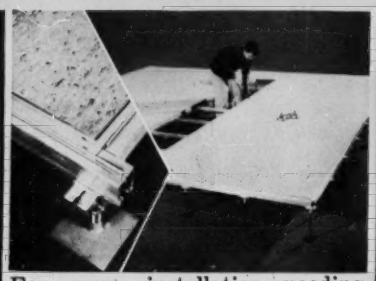

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From Minneapolis

AIS

to offer new line of scientific computers

Production of gp scientific computers is underway at Advanced Scientific Instruments, Inc., a new Minneapolis company which will be the third in that city to produce complete computer systems. According to Francis J. Alterman, president, the company expects to have its first, small-scale computer in operation some time next month.

The ASI machines will be of solid state design. Alterman has stated that ASI's computers will be able to communicate directly with one another in multi-computer installations without the need for buffer equipment. The computers will be adaptable to scientific computation, data reduction, large scale data processing and on- off-line process control applications.

With its research office and production facilities in Minneapolis, the company has also established an office in Washington, D.C., and since last April, has seen an increase in staff of from three to 30 employees. Forecasts call for a staff of 75 by January 1st.

Mr. Alterman, prior to organizing ASI, was manager of the Digital Computer Laboratory of General Mills Mechanical Division. Formerly, he served as head of the research section of W. L. Maxon Corp., New York; was chief engineer at the Institute of Mathematical Science at New York University, and was associated with Electronic Computer Corp. and Reeves Instrument Corp. Alterman's experience in the field of computer design dates back to work done on the original "Eniac" in 1942, under John W. Mauchly. ■

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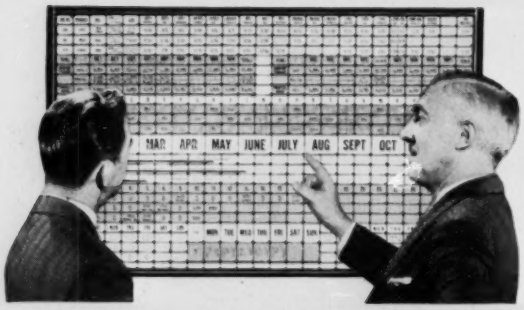

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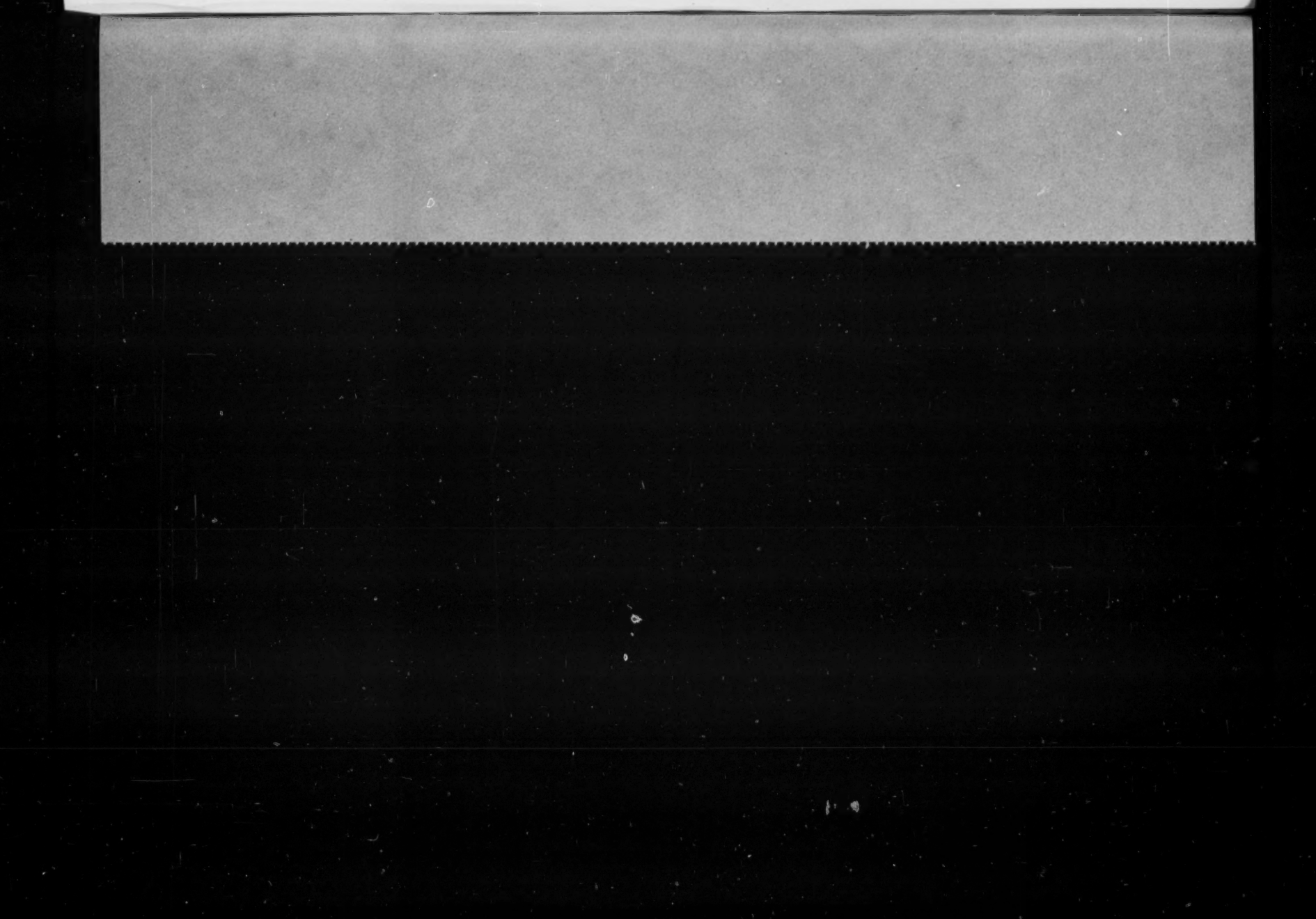

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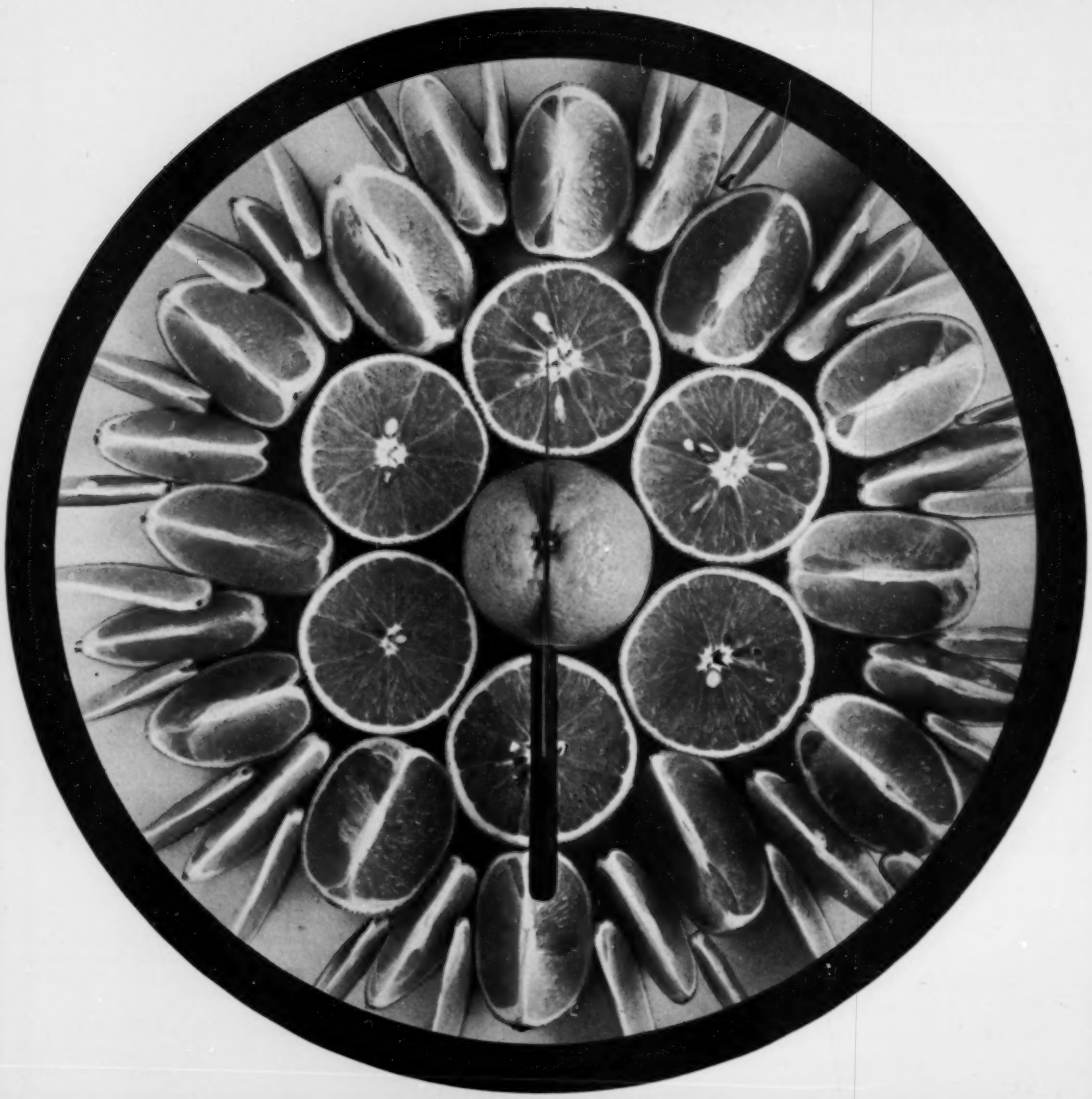

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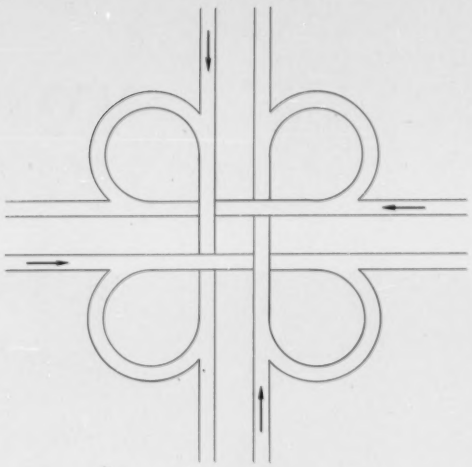
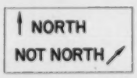


2. SAMPLE SIGN



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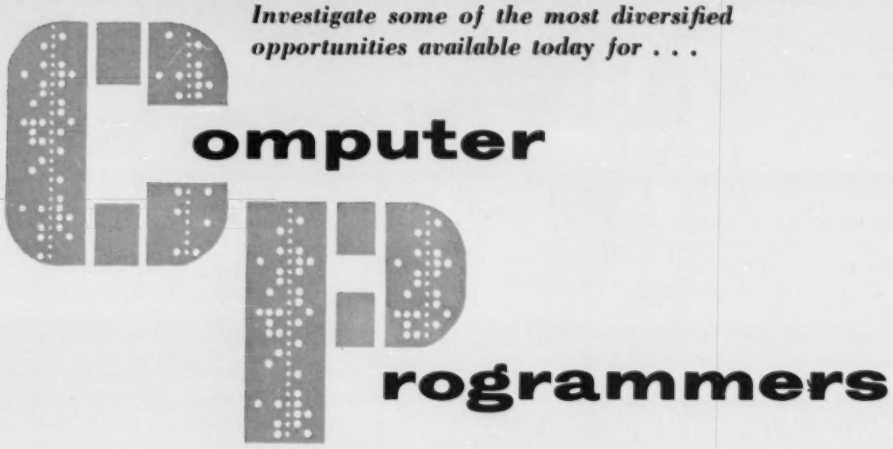

With the General Electric Computer Department at Huntsville, Alabama

Now beginning its fifth year of operation, the G-E facility at Huntsville has shown a striking increase in staff since its inception. And today, vitally important projects such as Saturn and Nova are being accelerated, creating still more positions for Programmers, Analysts and Operations Research specialists. This work is being done by General Electric for the computation division of NASA's George C. Marshall Space Flight Center.

Here is a functional breakdown of current opportunities:

SCIENTIFIC . . . Some of the projects include flight prediction and performance behavior analysis, thermodynamics, heat transfer, flutter analysis, advanced weather data, tracking systems evaluation, and acoustical vibrations studies. A special study team is concerned with the APT compiler. (Two 7090 computers and three 1401's are utilized by the scientific programming staff.)

BUSINESS . . . Systems Analysts and Programmers work with problems concerning costing, funding, manpower, inventory control, stock distribution, engineering documentation and other broad areas. (Utilize two 705's and two 1401's).

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GENERAL ELECTRIC

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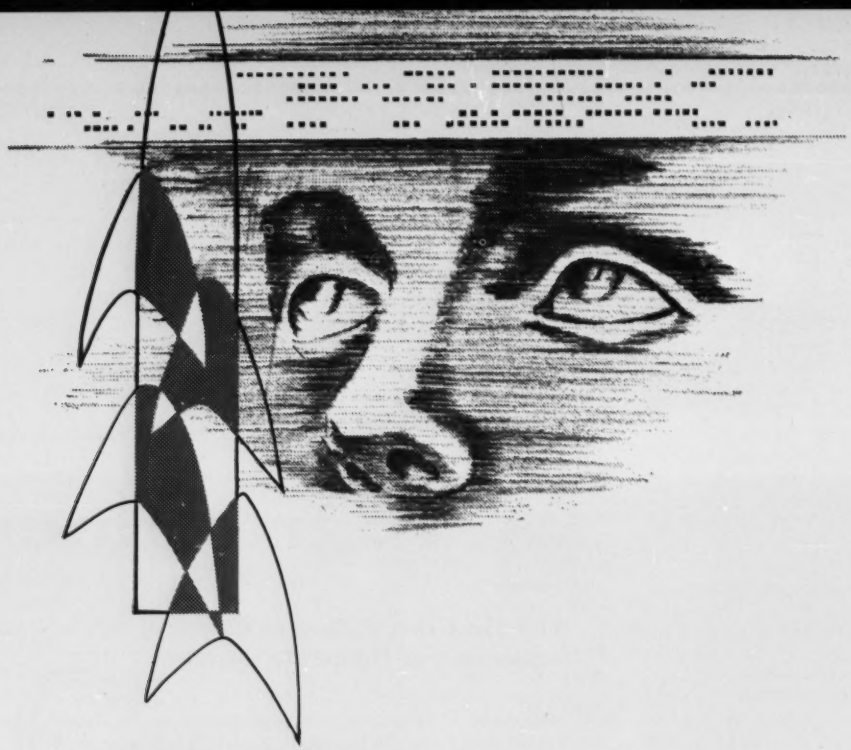

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CIRCLE 89 ON READER CARD

NEW LITERATURE

MATRIX OPERATIONS OF THE 2000: A booklet on matrix operations of the 2000 cites some of the unique features of the system which make for speed of operation, including the inverting of a 100 x 100 matrix in 50 seconds. MARKETING DEPARTMENT, PHILCO CORP., COMPUTER DIV., Willow Grove, Pa. For copy:

CIRCLE 130 ON READER CARD

INTERNATIONAL REPERTORY: An International Repertory, issued as a separate bound looseleaf volume, contains up-to-date information on approximately 300 computing laboratories in 30 countries. The name, address and officers of each Institution; type of equipment installed, as well as contemplated; field of experience; training available, and periodical publications will be included. For a copy of this publication send $6.50 to PROVISIONAL INTERNATIONAL COMPUTATION CENTRE, Palazzo degli Uffici, Zona dell 'EUR, Rome, Italy.

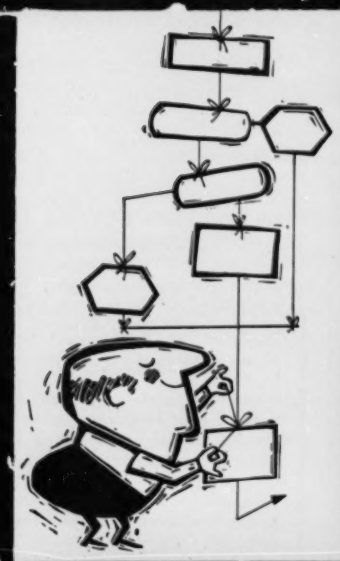
TRUE MODULARIZATION: A brochure describes miniaturized products and a new concept of "true modularization," applicable to advanced control and electronic data processing and handling equipment and systems. Five series of miniaturized circuit component modules, a complete family of miniaturized circuit cards for use in modular equipment and system construction, and accessory products are presented. CONTROL LOGIC, INC., 11 Mercer Rd., Natick, Mass. For copy:

CIRCLE 131 ON READER CARD

INSTRUMENTATION RECORDER/REPRODUCER: A product brochure highlights the FR-100C Instrumentation Recorder/Reproducer and gives detailed descriptions of tape transport and electronics, tape and reel sizes, tape speeds, controls, and recording modes. The system records in direct FM, PDM, or PCM modes. AMPEX INSTRUMENTATION PRODUCTS, Box 5001, Redwood City, Calif. For copy:

CIRCLE 132 ON READER CARD

SCANNER AND SUBTRACTOR: Two bulletins are available, one describing the SU-100 series transistorized digital subtractor, and the other, a high speed transistorized scanner. The subtractor is designed to determine the arithmetical difference between two inputs, and the scanner is designed



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Mr. Garrett Sanderson,
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New York City, New York.
PLaza 3-6060.

Mr. Robert L. Baker,
360 No. Michigan Ave.,
Chicago, Ill. ANdover 3-3131

New Literature . . .

to sequentially switch data points to a common output device. A complete description of characteristics is given for both mechanisms. DATEX CORP., 1307 S. Myrtle Ave., Monrovia, Calif. For copy:

CIRCLE 133 ON READER CARD

ANALOG COMPUTER: A pamphlet illustrates and describes the series AD-1 analog computers. Included is information on eight modules as well as a description of three basic computers. General technical specifications are given which include descriptions of amplifiers, balance check, multipliers and integrators. APPLIED DYNAMICS, INC., Ann Arbor, Michigan. For copy:

CIRCLE 134 ON READER CARD

DATA DISC FILE: The Data Disc File, a new addition to the 301, is highlighted in this illustrated bulletin. Facts and features of the system are given, including information on magnetic tape stations, remote inquiry, data record file, capacity and access time. RCA, ELECTRONIC DATA PROCESSING DIV., Camden 8, N.J. For copy:

CIRCLE 135 ON READER CARD

ALGOL SYNTACTICAL CHART: This chart provides a description of the complete syntax of ALGOL 60 presented in the form of a flow chart. The form of every possible construct in ALGOL 60 is shown in the chart, providing a means of catching syntactical errors in ALGOL programs prior to compilation. AUTOMATIC PROGRAMMING, BURROUGHS CORP., 460 Sierra Madre Villa, Pasadena, Calif. For copy:

CIRCLE 136 ON READER CARD

190 DELAY LINE: Complete applications data, including specific graphic operational characteristics, definitions and a description of the 192 magnetostrictive delay line are highlighted in this bulletin. The 190 is used in computers, and other systems which require information storage or pulse delay. DELTIME, INC., 608 Fayette Ave., Mamaroneck, N.Y. For copy:

CIRCLE 137 ON READER CARD

LOGIC BLOCK DIODE GATE: Technical bulletin 60-Q describes the type 2011 DG Logic Block Diode Gate, a 5-megacycle plug-in module which contains two independent 4-input diode gate circuits with transistor amplification. Characteristics are given including input, output, power requirements and switching time. RESE ENGINEERING, INC., A and Courtland Streets, Philadelphia 20, Penna. For copy:

CIRCLE 138 ON READER CARD

MACHINE TRANSLATION: An analysis report on machine translation gives information on a computer program that analyzes word interrelations and order for 95 percent of all sentences. The report gives a summary of foreign and domestic accomplishments in machine translation, and sets forth short and long-term goals and criteria of U.S. projects. For a copy of this report send 50¢ to OTS, U.S. DEPT. OF COMMERCE, Washington 25, D.C.

NEXT MONTH IN DATAMATION

Projected as the largest computer conference ever to be held in the U.S., the 1961 EJCC will receive complete, advance coverage in a 16-page section of the November issue. As a frequently requested reference guide, the Computer Characteristics Chart (incorporating some major hardware additions and a software scoreboard) will be published in this issue. A taped interview with Dr. Simon Ramo; the concluding segment of the RAND Symposium and a special report on compilers are among the many other highly readable irregularities on schedule for next month.

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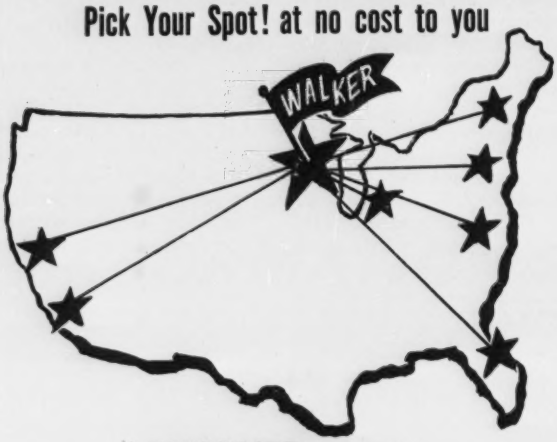

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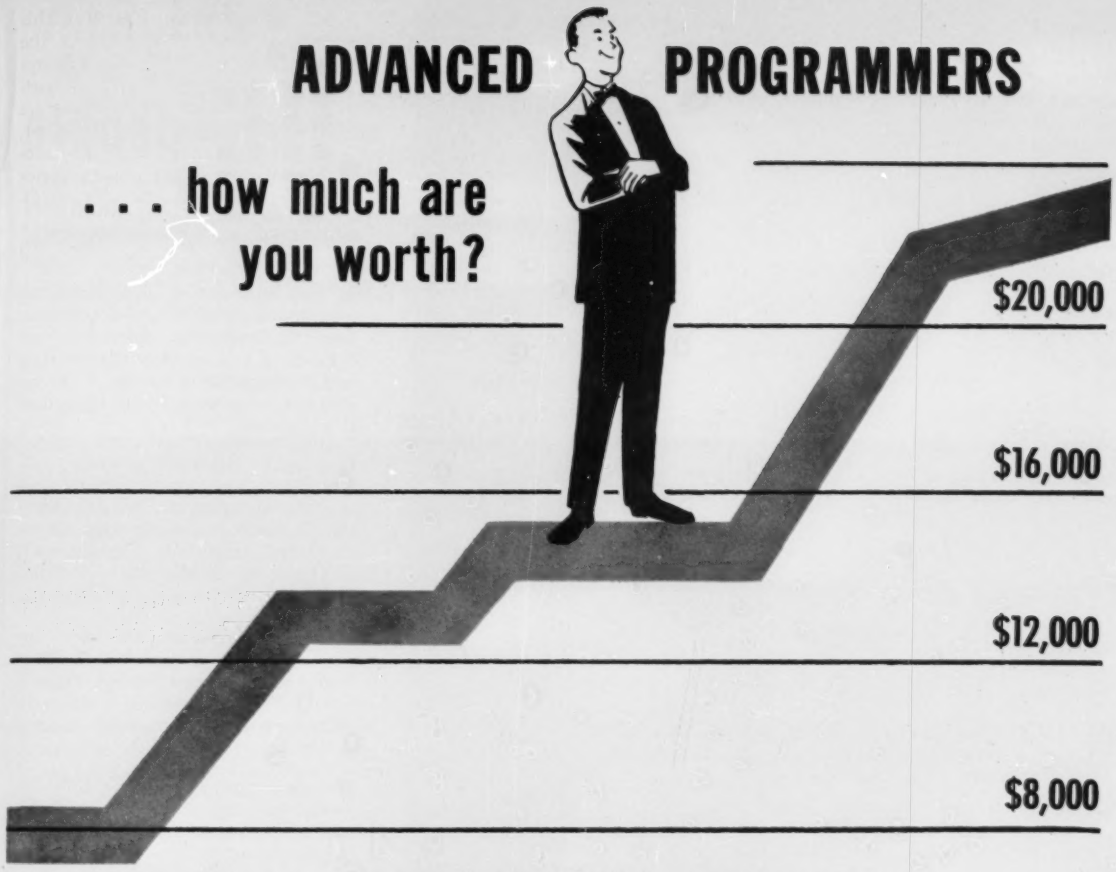

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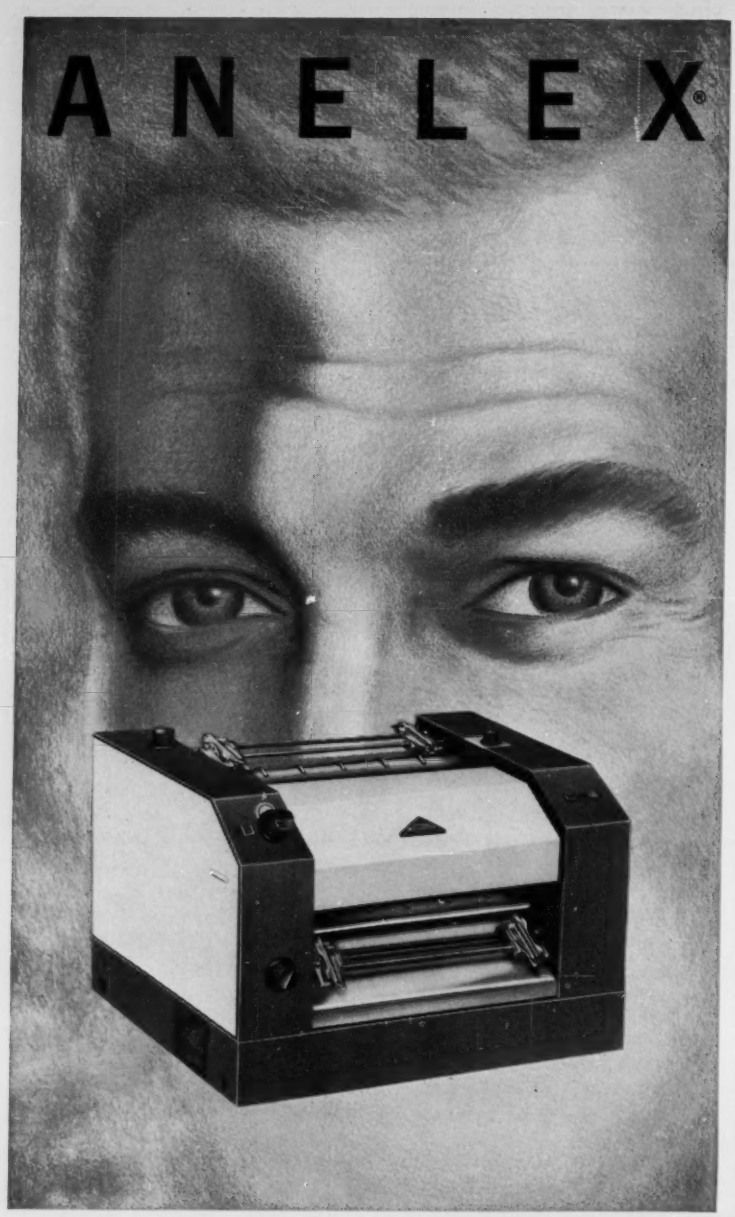

The diversity of applications for Anelex High Speed Printers has been limited only by man's ability to devise new uses for data processing systems . . . For more than twelve years, the most exacting requirements have been met with standard models from the complete line of Anelex Printers or with ingenious adaptations by Anelex Engineers.

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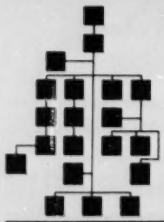


people IN DATAMATION

■ Jack Strong, long associated with computer department management at North American, has resigned to join C-E-I-R in Los Angeles. Also leaving North American is Owen R. Mock who is now associated with Computer Sciences Corp.

■ Jean E. Sammett, formerly staff consultant to the programming and analysis laboratory of Sylvania Electric Products, Data Systems Operations, has joined IBM. Miss Sammett has been one of the major contributors to the development of COBOL.

■ Dr. John Barker has been appointed acting director of Business Equipment Manufacturers Association. An executive search is currently underway for a permanent director of BEMA.

■ Minneapolis-Honeywell's EDP Division has appointed Frederick G. Miller director of operations. In his new position, Miller will be responsible for the division's manufacturing, systems test and field service operations. Two new divisional vice presidents, a director of product planning, and a technical advisor in automatic programming have also been appointed by Honeywell's EDP Division. Dr. J. Ernest Smith and John R. Lenox have been named vice presidents. Richard H. Bloch is director of product planning and Dr. Richard F. Clippinger has been named technical advisor to the headquarters staff.

■ Paul W. Larsen has resigned from the Teleregister Corp., of Stamford, Conn., to accept the new position of President of Information Retrieval Corp. of Washington, D.C.

■ Several key personnel changes have been reported last month by Philco Computer Division. John M. Nisbet, vice president and marketing manager, resigned from the company and was replaced by Robert Mather, formerly of IBM. Herb Bright, formerly with the data processing division of the Business Equipment Manufacturers Association, has joined Philco as technical assistant to the marketing manager.

MERGERS & new firms in DP

■ Data Analysis Corp., a new subsidiary of Dynalectron Corp., represents an expansion for the parent company in the field of automatic data analysis, handling and processing. William S. Shoaf is president, and Charles C. Mann, vice president of the new subsidiary located in Washington, D.C.

CIRCLE 120 ON READER CARD

■ National Computer Analysts of New York, Inc., is a new firm offering consulting services to both manufacturers and users of edp equipment including the preparation of software packages. President of the company is Michael Miskulin, formerly with IT&T, Underwood, RemRand, and the Manufacturers Trust Co.

CIRCLE 121 ON READER CARD

■ Datapulse, Inc., is a new firm located in Inglewood, Calif. which will market a product line of data simulation, digital communication and pulse test equipment. The company anticipates capitalizing at $300,000.

CIRCLE 122 ON READER CARD

■ Data Technology Corp. is a new company specializing in advanced data processing systems in the fields of medical research, and research in the physical sciences related to space age projects. The company, headed by Leland W. Bagby, is located in Palo Alto, Calif., and is capitalized at $200,000.

CIRCLE 123 ON READER CARD

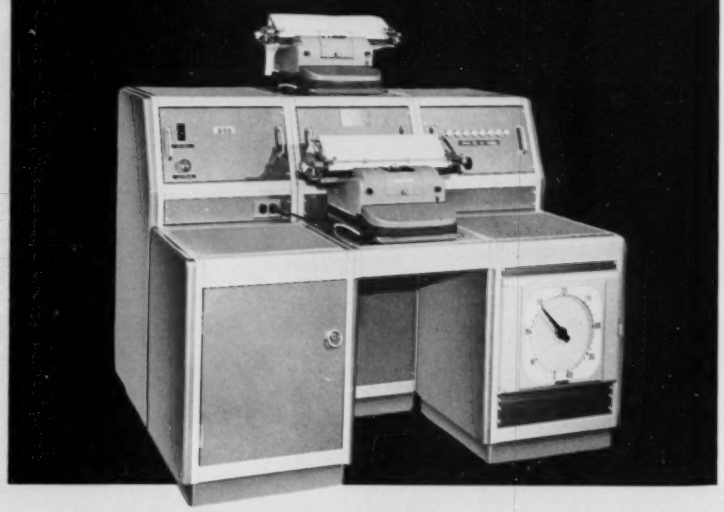
■ A new corporation, Ganlon Industries, has been formed to specialize in the engineering and design of digital data handling systems, analog control systems, automatic checkout equipment and transistorized circuit design. John E. Organist is chief administrative officer of Ganlon Industries, located in Glen Cove, New York.

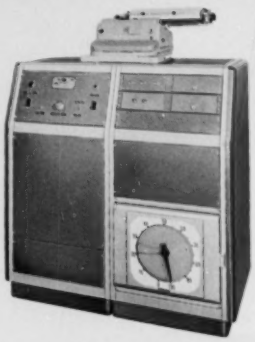
CIRCLE 124 ON READER CARD

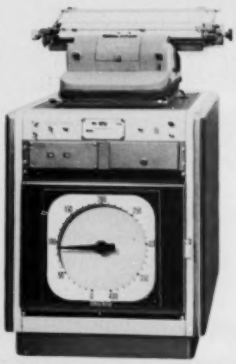
■ A new electronics firm, Diginamics Corp. has been established in Minneapolis, to develop new methods of translating analog to digital information. The officers, all formerly associated with the Aeronautical Division of Minneapolis-Honeywell, include James H. Foster, president; Arney Landy, Jr., vice president and secretary, and Robert E. Wolff, vice president and treasurer.

CIRCLE 125 ON READER CARD

Read-out the unexcelled flexibility in data processing equipment housing with







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Must have experience on large-scale computing equipment in designing and implementing systems programs such as monitors, compilers and input-output control routines. Will assist in defining and creating new multiprogramming systems designed to serve real-time data processing needs by means of advanced TELE-PROCESSING* systems.

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Must have a sound accounting or engineering background as well as an interest in, or knowledge of, economics, mathematics, statistics and marketing. Will assist in determining marketability of, and providing applications requirements for, new IBM data processing systems. This involves studying and documenting business activity and translating business requirements into a definition of functional machine characteristics.

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The IBM Laboratory at San Jose provides a campus-like atmosphere for doing advanced work. The IBM program includes diverse benefits which have set standards for industry. There are ample opportunities for continued education. All qualified applicants will be considered for employment without regard to race, creed, color or national origin. Please write, outlining your background and interests to . . .

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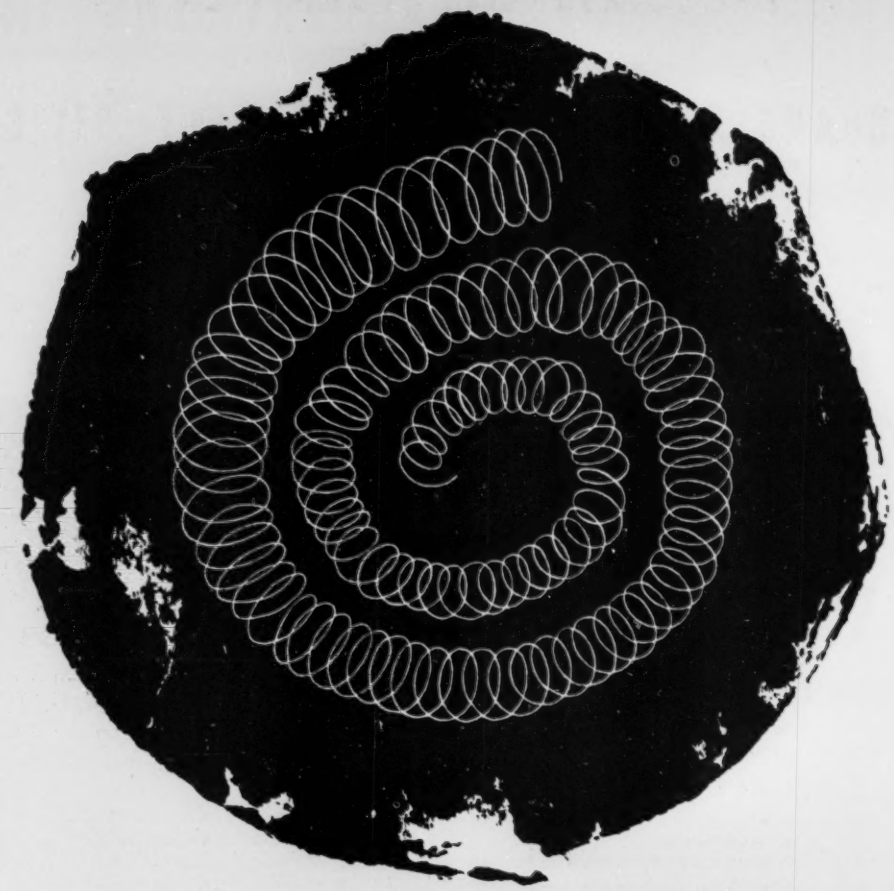

Said Svante Arrhenius: *"The change of the logarithm of a chemical reaction rate constant with respect to temperature, is inversely proportional to the square of the absolute temperature."*

The aerospace industry is searching constantly for strong, light-weight, heat-resistant materials. Finely-spun glass fiber, bonded with a plastic binder, is beginning to exhibit superior properties. Until recently the glass fiber has been far more heat-resistant than any binder.

Scientists at Lockheed Missiles & Space Company, however, have developed a compatible binder. This now makes it necessary for the glass-producing industry to evolve a glass to match its superior heat-resistance.

Comparable successes are being achieved in dozens of disciplines in which Lockheed is engaged. As Systems Manager for the DISCOVERER, MIDAS, and other satellites, and the POLARIS FBM, Lockheed probes all areas of aerospace endeavor.

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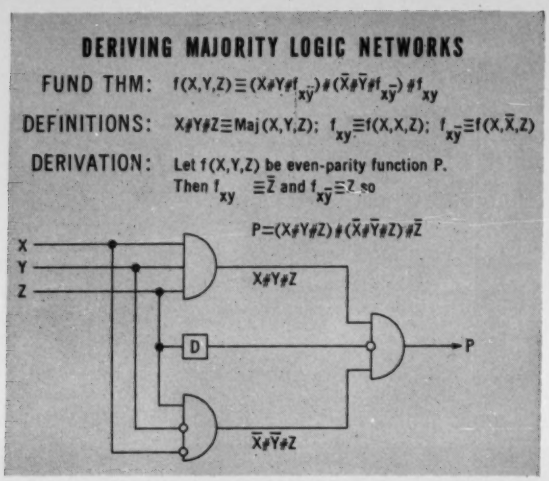

The fundamental theorem of majority-decision logic, a typical product of Univac's Mathematics and Logic Research Department, has practical as well as theoretical interest. The even-parity checker derived above from the fundamental theorem can be treed to determine the parity of 3^n bits in n logic levels using only $\sum_0^n 3^i$ three-input majority gates.

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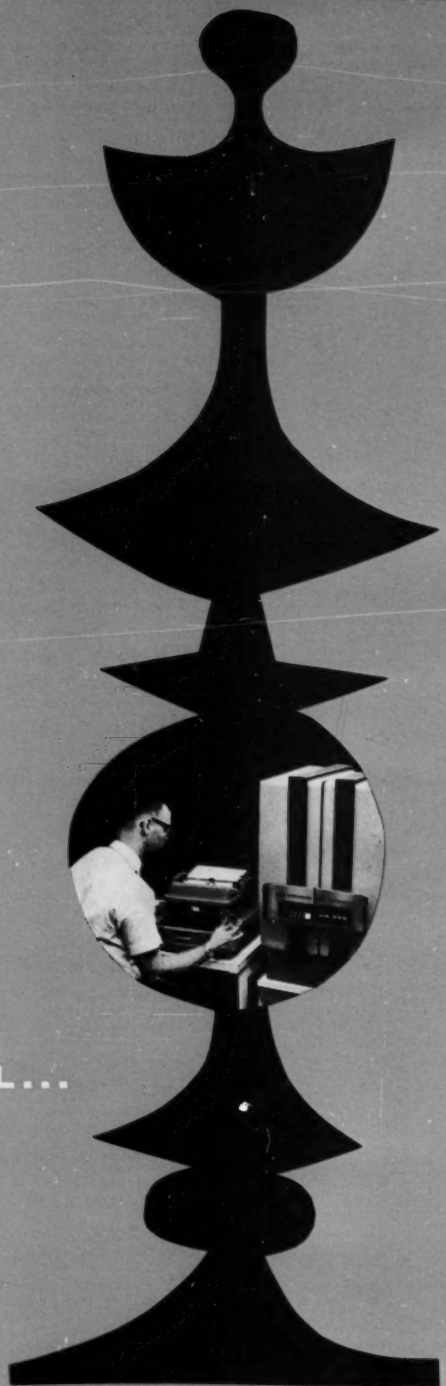

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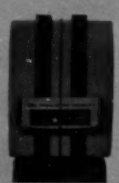

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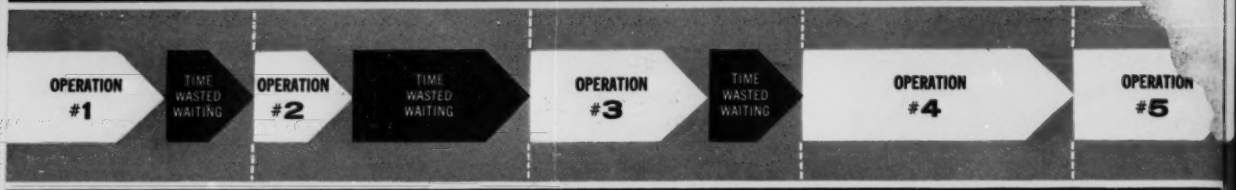

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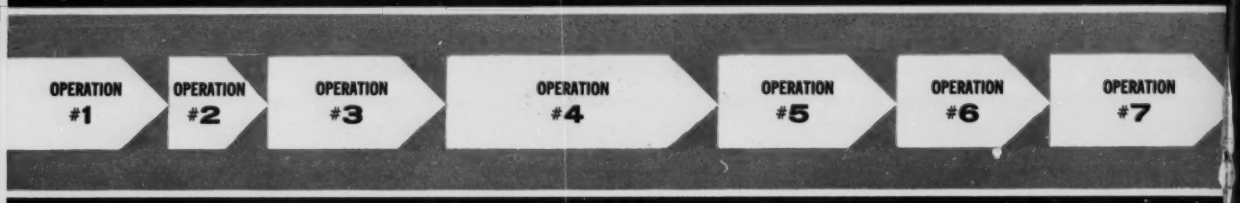

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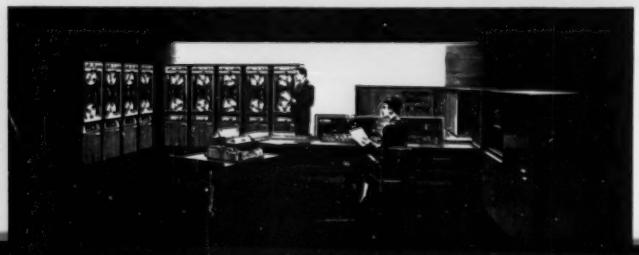

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